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QUAD-CITY REGIONAL SOLID WASTE PROGRAM

William T. Ingram, et al

Quad-City Solid Wastes Committee
Paterson, New Jersey

1968

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QUAD-CITY SOLID WASTES PROJECT

AN INTERIM REPORT

June 1, 1966 to May 31, 1967

Prepared by Quad-City Solid Wastes Committee
Staff, William T. Ingram, and Frank P. Francia
under Grant No. D01-UI-00026.

Details of illustrations in
this document may be better
studied on microfiche.

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
National Center for Urban and Industrial Health
Solid Wastes Program
Cincinnati
1968

PREFACE

An estimated 800 million pounds of solid wastes of all types are produced in the United States every day. What to do with these solid wastes, how to dispose of them without needlessly endangering public health and welfare, and how to recover and reuse valuable materials now "thrown away" are among the most challenging and perplexing of current national problems. Because of lack of suitable planning, interest, and public understanding, these problems have reached such proportions that nationwide attention is demanded and action for the development of adequate solutions must be taken.

Intensified action concerning these problems was made possible by the Solid Waste Disposal Act, Title II of Public Law 89-272, which was signed by the President on October 20, 1965. This legislation directs the Secretary of the Department of Health, Education, and Welfare to initiate, encourage, and support a national program aimed at discovering and evaluating better methods of coping with the solid waste problem.

The Secretary is authorized (1) to conduct and support research on the nature and scope of the problem, on methods of more safely and efficiently collecting and disposing of solid wastes, and on techniques for recovering from solid wastes potentially valuable materials and energy; (2) to provide training and financial and technical assistance to local and State agencies so that they can survey their needs in the solid waste area and plan for the development and staffing of programs capable of meeting those needs now and in the years to come; and, (3) to encourage and support projects that may demonstrate new and improved methods of solid waste collection, handling, and disposal.

To carry out these responsibilities, the Solid Wastes Program was established in the National Center for Urban and Industrial Health of the Public Health Service. Among the responsibilities with which the Program is charged is that of providing grant support for demonstrations relating to the development and application of new and improved methods of solid waste collection, storage, processing and ultimate disposal; and also for studies and investigations that may lead to a demonstration of improved disposal practices, or may provide solutions for regional or national solid waste disposal problems. Associated with this is the responsibility of collecting and making available by appropriate means the results of, and other information pertaining to, such federally supported demonstrations, studies and investigations.

Accordingly this report has been reproduced by the Public Health Service to disseminate as widely as possible the latest available information and findings of a project that has received grant support from the Solid Wastes Program. It is hoped that it will provide those working in this field with useful information that will be of assistance in developing approaches to the solutions of their solid waste disposal problems.

This is an interim report of project progress, and additional work is currently underway to complete the project as identified in the abstract included herein. Additional progress reports, when received, will also be made available by the Public Health Service for widespread distribution and use. The final report will be issued as a Public Health Service publication.

Richard D. Vaughan
Chief, Solid Wastes Program

ABSTRACT OF STUDY AND INVESTIGATION GRANT NO. D01-UI-00026

TITLE: Quad-City Regional Solid Waste Program

GRANTEE: Quad-City Solid Wastes Committee
City Hall
Paterson, New Jersey 07505

PROJECT DIRECTOR: Frank P. Francia, P. E.
Room 53, City Hall
Paterson, New Jersey 07505

DATE PROJECT STARTED: June 1, 1966

DATE PROJECT ENDS: May 31, 1968

OBJECTIVES: To develop a regionalized program for solid waste disposal practices for a group of adjacent municipalities having a common problem of solid wastes handling, and to establish the administrative means for implementing the program developed.

PROCEDURES: Studies will be made to determine the quantity and characteristics of solid wastes produced in each municipality. Meteorological investigations will be made to determine the influence that incineration at potential sites might have on air pollution in the area. A thorough evaluation of various disposal methods will be made. Much of the work will be performed by the committee's engineering consultant, Mr. William T. Ingram, who will also provide overall advisory services for the project.

QUAD-CITY SOLID WASTES PROJECT

FIRST ANNUAL REPORT

June 1, 1966 to May 31, 1967

QUAD-CITY SOLID WASTES COMMITTEE

Community	Commissioner
Paterson, New Jersey	Frank X. Graves, Jr. - Chairman
Clifton, New Jersey	William Holster - Vice-Chairman
Passaic, New Jersey	Paul De Muro - Secretary
Wayne, New Jersey	Edward Sisco - Treasurer

Office

City Hall, Paterson, New Jersey

Paterson, Clifton, Passaic, Wayne
Regional Solid Wastes Program
Grant No. 1-D01-SW-00026-01
U.S. Department of Health, Education, and Welfare
Public Health Service

QUAD-CITY SOLID WASTES COMMITTEE
ROOM 53 - CITY HALL
PATERSON, NEW JERSEY 07505
TELEPHONE 684-5800 – EXT. 122

FRANK X. GRAVES, JR.
CHAIRMAN
WILLIAM HOLSTER
VICE-CHAIRMAN
PAUL DE MURO
SECRETARY
EDWARD SISCO
TREASURER

FRANK P. FRANCIA
PROJECT DIRECTOR

TO: Commissioners
Quad-City Solid Wastes Committee

Re: Federal Grant
1-DO1-SW00026-01

I take pleasure in presenting to the Quad-City Solid Wastes Committee our First Annual Report.

This report records the progress that has been made toward meeting the five objectives delineated in our grant application.

1. To evaluate, develop, and demonstrate practices involving a combination of municipalities having a common problem of solid wastes handling.
2. To establish the means for administering and operating a regionalized disposal system.
3. To correlate a regional program with a state program and provide basic data to the State Health Department in furtherance of its long range solid waste disposal planning.
4. To construct and demonstrate a pilot operation selected as best for the region.
5. To encourage regional solid waste handling for all urban areas of Passaic County through demonstration of a program applicable to four major municipalities of the County.

Very truly yours,

Frank P. Francia

Frank P. Francia
Project Director

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FOREWORD

More than ten years has elapsed since a group of Administrators and Engineers representing Clifton, Passaic and Paterson, New Jersey met to consider the future problems of solid waste handling that these communities faced. Even then the concept of a coordinated Tri-City disposal agency was discussed.

By 1966 the three Cities plus the fast growing Town of Wayne appreciated fully the implication of restricted areas for landfill and the ultimate possibility that landfill at sites outside of the four communities could be denied.

Project work reported here has two prime purposes; the first is that of finding a legal pathway that will permit four communities with a combined population now approaching 350,000 to manage jointly a total solid waste program. The second is that of developing technically for the Quad-City Community the most efficient, least expensive and best controlled methods for treating and disposing of the total solid waste generated in the region.

Our work for the past year has been dedicated to these purposes. We believe that steady progress has been made and that our plans for meeting the Quad-City Community need are fast approaching realization.

Frank P. Francia

Frank P. Francia
Project Director

William T. Ingram

William T. Ingram
Consultant

QUAD-CITY SOLID WASTES PROJECT

Staff

This First Year's Summary Report was prepared by the Quad-City Solid Wastes Committee Staff and Consultant under the program direction of Mr. Frank P. Francia, Project Director. Significant contributions to the report have been received from the Technical Advisory Committee, State and Federal representatives.

Below is a listing of personnel involved in the Quad-City Solid Wastes Committee Project.

	Affiliation
Frank X. Graves, Jr.	Commissioner representing Paterson - Chairman
William Holster, P. E.	Commissioner representing Clifton - Vice-Chairman Member - Technical Advisory Committee
Paul De Muro	Commissioner representing Passaic - Secretary
Edward Sisco	Commissioner representing Wayne Treasurer
William T. Ingram	Consultant
Frank P. Francia, P.E.	Program Director, Staff
John A. Lacz, P. E., P. P.	Senior Project Engineer, Staff
John B. Clemente, C. E.	Project Engineer, Staff
Edward L. Patterson	Executive Secretary, Staff
Thomas J. Fitzmaurice, P. E., L.S.	City Engineer, Paterson Technical Advisory Committee
John W. Leidy, P. E., L. S.	Business Administrator, Wayne Technical Advisory Committee
Ralph Sandor, P. E., L. S.	City Engineer, Passaic Technical Advisory Committee
J. Allen Yager, M. D.	Health Officer, Paterson Technical Advisory Committee
Oscar Aquino	Health Officer, Wayne
Thomas C. Jones	Project Monitor, Public Health Service
Everett L. MacLeman	Regional Program Director, Public Health Service
Russell E. Cummings	Regional Consultant, Public Health Service
Henry C. Steed, Jr.	Chief, Office of Grants Administration, Public Health Service
James J. Murphy	New Jersey State Department of Health, Office of Solid Wastes

SUMMARY

In the first year of operations under this project much has been accomplished in line with the broad objectives:

1. To evaluate, develop, and demonstrate practices involving a combination of municipalities having a common problem of solid wastes handling,
2. To establish the means for administering and operating a regionalized disposal system,
3. To correlate a regional program with a state program and provide basic data to the State Health Department in furtherance of its long range solid waste disposal planning,
4. To construct and demonstrate a pilot operation selected as best for the region,
5. To encourage regional solid waste handling for all urban areas of Passaic County through demonstration of a program applicable to four major municipalities of the County.

The Quad-City region comprising the cities of Clifton, Passaic, and Paterson and the Town of Wayne, New Jersey, had the benefit of an original study financed by the three cities. The report of that study titled "Refuse Collection and Disposal Requirements for Contiguous Communities" was published in May 1961. In the Summary of that report it was stated:

> "To continue the practice of independent collection and disposal of refuse by the three cities is an anomaly. Water services have already been regionalized, sewage and liquid waste disposal services are in the process of being regionalized. Refuse handling must surely follow that trend to avoid innumerable technical problems associated with the ultimate disposal of solid wastes and to conserve public funds by efficient management of a mandatory public utility service."

In September 1966 the Consultant prepared an updated report titled "Refuse Collection and Disposal Quad-City Area - September 1966--A Supplement to Refuse Collection and Disposal Reports for Contiguous Communities, May 1961" including current information concerning the three cities and including a background of similar information for the Town of Wayne. In that report it was stated:

> "Although sanitary landfill and incineration remain as the most likely choices of disposal method, consideration must be given to developments along other lines that are at research or pilot plant demonstration stage now."

It was further stated:

> "Characteristics of the Quad-City area are such that political boundaries between the communities have little bearing on the total community problem of waste collection. The four communities should find as quickly as possible, a legal basis for handling the entire problem of refuse collection and disposal on a coordinated basis as one joint program. This program should actively encourage the inclusion of Little Falls Township, West Paterson, Borough of Totowa, Haledon, Prospect Park, North Haledon and Hawthorne, into a lower Passaic County region along with the Quad-City communities. It is suggested that Title 40, Chapter 48B, New Jersey Statutes, be investigated as a possible means of establishing a joint operation of solid waste services."

and,

> "The present Quad-City Solid Waste Committee should utilize its demonstration project to evaluate within the year several alternate means of collecting, treating and disposing of solid waste, including all household, commercial and industrial solid wastes."

A detailed presentation of technical data is presented in the following pages and summarized here. Table 1 has been prepared as a fact sheet presenting a quick review of essential information. That information was obtained by field investigation, assay, analysis and projection.

The official 1960 census was used as a basis for estimating per capita data. Three assays conducted in October 1966, and February and May 1967 provided data on municipally collected solid wastes. Plant visits to 32% of the industrial establishments in the four communities provided information for projection of industrial waste data. Field visits provided information on construction/demolition production. Community Public Works Departments and contract scavengers furnished data on periodic clean-up and street cleaning production.

The three assay data indicate that the municipal waste production is 2.74 #/capita/day. The industrial survey shows a Quad-City production of 3.31 #/capita/day. Total waste production in the four communities amounts to an estimated 9.39 #/capita/

Table 1

Quad-City Solid Wastes Project

First Annual Report
Fact Sheet

Item	Paterson	Clifton	Passaic	Wayne	Quad-City
1. Total Wastes Production					
Municipal					
#/cap/day	2.46	2.67	2.47	4.18	2.74
$/ton	9.89	7.32	9.70	10.21	9.27
tons/day	185.0	117.7	64.0	91.0	457.7
Industrial					
#/cap/day	2.89	3.78	3.06	1.59	3.31
tons/day	205.98	154.66	82.32	23.33	508.51
Construction					
#/cap/day	0.20	0.59	0.21	1.57	0.44
tons/day	14.42	24.30	5.59	23.01	67.33
Demolition					
#/cap/day	2.20	1.32	2.77	1.87	2.03
tons/day	156.68	53.97	74.52	27.40	312.57
Clean-Up Week					
#/cap/day	0.22	0.28	0.11	1.23	0.31
tons/day	15.65	11.45	2.96	18.05	47.62
Street Sweepings					
#/cap/day	0.14	1.00	0.45	1.57	0.56
tons/day	9.8	41.0	12.2	23.0	86.0
Total Waste					
#/cap/day	8.11	9.64	9.07	12.01	9.39
tons/day	586.55	403.08	241.59	205.79	1479.73
2. % Composition of Municipal Waste					
Paper	39.80	46.80	44.41	53.66	45.63
Wood	3.38	3.18	3.45	1.69	3.00
Plastic	2.97	2.34	2.33	2.39	2.52
Glass	9.96	3.73	5.24	5.38	6.22
Metal	12.91	6.95	8.68	6.96	9.08
Stone, Sand	7.04	8.53	8.65	6.16	7.65
Organics	20.22	26.76	21.43	22.51	22.62
Rags	5.07	2.20	7.76	1.69	4.45

Table 1 (continued)

Item	Paterson	Clifton	Passaic	Wayne	Quad-City
3. Chemical Characteristics					
As Received Lab. Sample					
% Moisture	41.7	39.1	45.3	47.2	43.3
% Carbon	26.2	29.3	24.6	25.8	26.5
% Nitrogen	0.68	0.83	0.90	0.58	0.75
BTU/#	5,199	4,635	4,976	4,332	4,786
% Volatiles	45.9	49.9	43.1	44.9	46.0
% Ash	9.7	10.7	11.4	8.0	10.0
Dry Basis					
% Carbon	44.6	46.8	44.7	48.9	46.2
% Nitrogen	1.19	1.68	1.89	1.14	1.48
BTU/#	9,012	7,340	8,958	8,719	8,507
% Volatiles	86.2	86.1	84.3	87.9	86.1
% Ash	13.1	13.9	15.8	12.1	13.7
4. Adjusted Estimate Chemical Characteristics					
As Collected					
% Moisture	27.5	28.1	30.2	34.8	30.1
BTU/#	3,426	3,281	3,598	3,145	3,364
% Volatiles	34.6	37.3	32.4	34.4	34.7
% Ash	37.8	34.6	37.3	31.0	35.2
Dry Basis					
BTU/#	5,917	5,236	6,563	6,361	6,016
% Volatiles	58.4	61.5	58.0	65.2	60.7
% Ash	41.6	38.5	42.1	34.7	39.3
5. % Composition in Total Industrial Waste					
Paper	45.50	38.33	35.96	63.51	42.73
Wood	13.03	2.95	11.23	1.05	7.34
Plastic	7.00	10.81	16.95	25.39	12.61
Glass	6.51	1.73	2.08	0.36	3.03
Metals	5.45	6.06	2.03	0.75	4.48
Stone, Sand	5.59	6.48	4.38	-	5.09
Organic Chemical	0.14	5.48	5.26	0.21	3.32
Textiles, Rags	6.92	1.17	2.56	2.71	3.28
Ceramics	-	0.51	0.02	-	1.57
Inorganic Chemical	-	0.53	-	0.18	0.19
Petro-Chem.	0.92	4.98	0.81	0.38	0.23
Rubber	-	1.22	5.59	0.28	2.45
Mixed Commercial	0.15	7.45	5.62	0.01	4.15
Food	4.22	8.28	-	4.49	5.00
Miscellaneous	4.57	4.02	7.51	0.68	4.53
Total	100.00%	100.00%	100.00%	100.00%	100.00%

Table 1 (continued)

Item	Paterson	Clifton	Passaic	Wayne	Quad-City
6. Miscellaneous Data					
Population (1960)	142,301	81,831	53,770	29,353	307,255
Area (Sq. Mi.)	8.3	11.2	3.2	25.7	48.4
No. of Industries	562	233	208	40	1,043
No. of Industries Surveyed	125	106	71	22	324

day. Production in the Quad-City community currently amounts to 460 tons of municipal waste, 500 tons of industrial waste and a total of 1500 tons per day.

BTU of municipal waste will run about 3,400 BTU/# in the field with about 30% moisture content and about 35% by weight inert or non combustible materials based on laboratory assay.

Municipal waste includes approximately 46% paper and paper products, and 23% organic garbage. Glass, metal and plastics account for about 18% of the production. By comparison industrial waste composition includes about 43% paper and 5% organic food wastes. Glass, metal and plastics amount to about 20% of the total.

Air ventilation studies to date suggest strongly that any stack emissions emanating from facilities in the vicinity of the Passaic River Valley floor must be the subject of severe review from the standpoint of air cleaning.

Geological studies indicate that any form of landfill must be so located that it will not be in contact with either groundwater or bedrock and preferably should be in areas of glacial deposit to avoid potential pollution of water resources.

Sixteen possible locations for treatment and/or disposal of the region's solid wastes have been considered and nine have been investigated in some detail. The ultimate investigation of sites is contingent on the methodology finally selected by the Commission or on the system selected for solid waste disposal demonstration.

Many alternate methodologies for the treatment and disposal of solid wastes have been investigated. These include incineration, landfill, composting, compaction, long distance rail haul with transfer stations, high temperature combustion, grinding, and salvaging. Of these three primary methodologies have been selected for intensive investigation with the thought that alone or in combination a complete processing system meeting the needs of the Quad-City community can be found. These now include:

1. High Temperature Combustion.
2. Long haul with transfer stations and sanitary landfill.

3. Incineration with sanitary landfill.
4. Appropriate auxiliary processes such as grinding, shredding and compaction in support of the primary methodology.

The Quad-City Solid Wastes Committee was established legally for a three year term in July 1966. That Committee has utilized the services of the legal counsels of each community in framing a document acceptable to all. As of this writing the weight of evidence continues to indicate that as soon as the professional staff completes their recommendation on a system of solid wastes management acceptable to the four communities, the legal authority will follow shortly.

The authority proposed will be known as "The Lower Passaic County Solid Wastes Management Authority."

It is anticipated now that the professional staff will have completed its recommendation and will have prepared a proposal for a demonstration grant prior to 1 December 1967. It is likewise anticipated that the modus operandi for completing the legal aspects of authority formation will be established at the time of filing the demonstration grant application.

It has been demonstrated in this report that progress has been made in defining the problem, selection of alternate technical solutions, and developing the means for managing and administering a solid wastes program on a regional basis, and that these efforts correlated with a statewide program may do much to encourage similar regionalized activity by pointing the way and pioneering many of the troublesome aspects of such activity.

It has been recommended that the second year of study be addressed to:

1. Completion of a fourth assay to obtain a four season composite of municipal solid wastes.
2. Investigation of the following methodologies in detail:
    a. High Temperature Combustion.
    b. Incineration
    c. Long haul sanitary landfill (as an intermediate solution).
    d. Combination of the above.

   e. Auxiliary processing required to support the above methodologies.

   f. Air cleaning adjuncts to the above.

   g. Investigation of waste heat utilization processes including either steam turbine, or direct drive gas turbine.

3. Supplemental assays of industrial waste to obtain a firmer knowledge of composition and chemical characteristics.

4. Preparation and submission of a demonstration grant proposal to the Public Health Service Solid Wastes Program Administration.

5. Completion of all legal aspects related to and the execution of all actions required to bring about the formation of a Solid Wastes Management Authority in which the communities of Clifton, Passaic, Paterson and Wayne, New Jersey, are parties jointly to the action.

SECTION 1

INTRODUCTION

A Background of Information

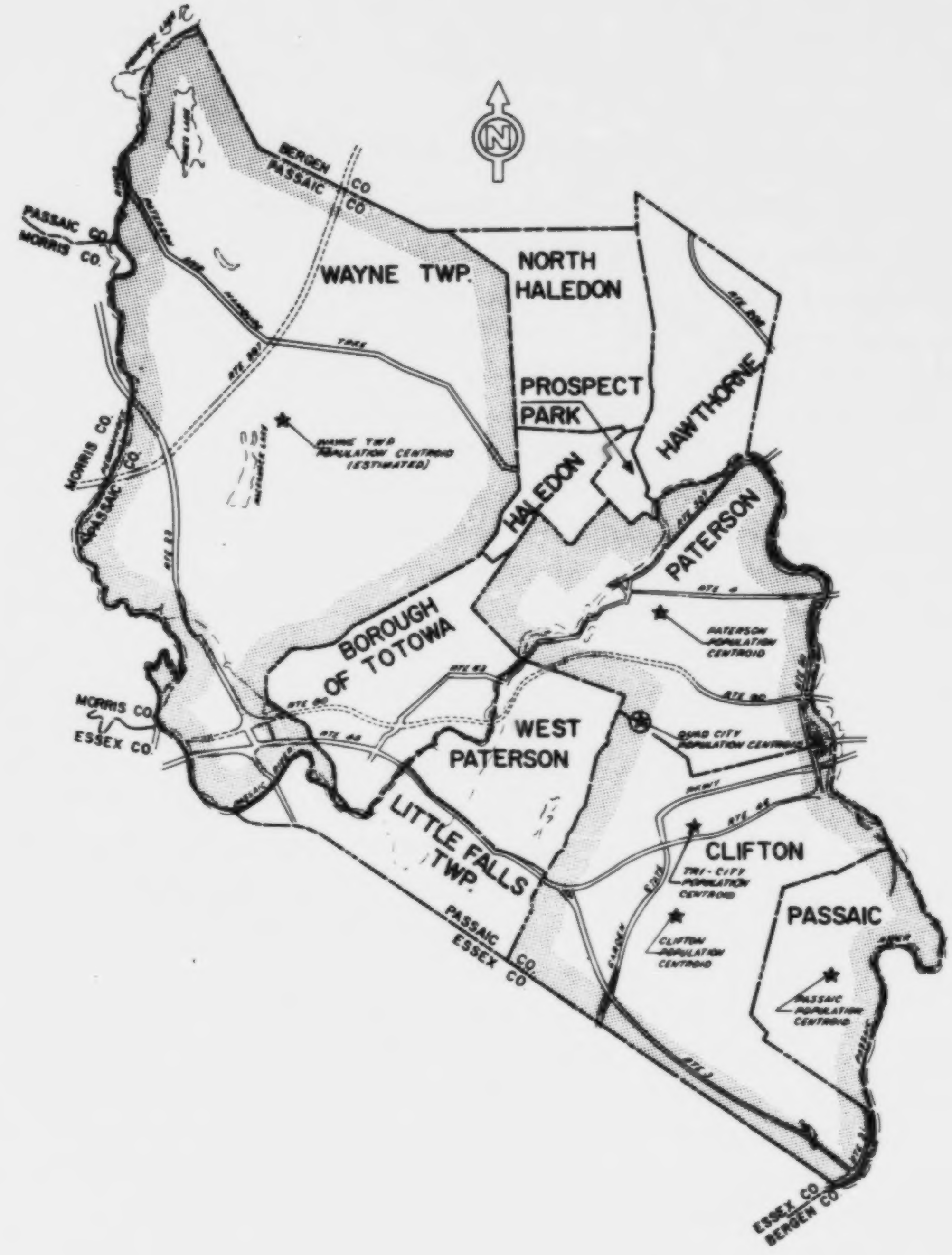
The cities of Clifton, Passaic and Paterson form a small urban region in Passaic County in the State of New Jersey. The Township of Wayne is a rapidly expanding area lying to the west and north of the three cities and at no place contiguous with them. The town is separated from the three cities by Little Falls Township, West Paterson, Borough of Totowa, Haledon, Prospect Park, North Haledon and Hawthorne, as shown in Figure 1-1.

The Passaic River loops around the three cities on the easterly boundaries and forms the Wayne boundary with Essex County. The Pequannock River is the western boundary between Wayne and Morris County and the Ramapo River separates Wayne from Pompton Lakes across a restricted neck of Passaic County connecting to Bergen County on the north.

Garrett Mountain, rising sharply, separates Clifton from West Paterson and provides a barrier so that access from the west is limited to Route 46 on the south and local roads into Paterson on the north. Highway Route 80 is under construction and will pass through West Paterson, Totowa and the southern tip of Wayne. Access from the east and south is multiple with five major highways and one parkway.

Singac Brook runs through a wide valley in Wayne to the west of Second Watchung Mountain and Preakness Mountain, the high point of Quad-City region at an elevation of over eight hundred feet; thus the Town of Wayne has several hundreds of feet change in elevation in contrast to Clifton, Passaic and Paterson, located in the Passaic Valley.

With the exception of the seven communities noted, the Quad-City region comprises the southerly extension of Passaic County between Bergen, Essex and Morris counties.



PORTION OF PASSAIC COUNTY
WITH COMMUNITIES OF QUAD CITY REGION

SCALE IN FEET
0 6,000 12,000

Figure 1-1

It may be observed from Figure 1-2 that Wayne is the community having most rapid growth among the four, while Passaic is losing population slowly. Passaic County population outside the Quad-City area displayed a more rapid growth in all periods from 1930 than the area or region included in this study. Since the upper portion of Passaic County is rural in character, there is a strong suggestion that the seven communities not now part of the region are also growing rapidly and these communities may have or may be expected to have solid wastes handling problems similar to those that have developed in the Quad-City group.

Clifton

The City of Clifton became a separate municipality in 1917 and has been growing rapidly and continuously until the present time. Early Clifton was a rural and residential community lying between the industrial and commercial areas which surrounded it. The development of Clifton was primarily that of a community on a farm to town road system with major transit arteries passing through the city connecting one center to the other.

With the development of the automobile as an easy method of transit, Clifton started to grow rapidly. It offered greater space among older and more congested areas which could be developed residentially for those employed in adjacent industrial areas.

In the decades from 1940 to 1950 and from 1950 to 1960 the population of Clifton has been increasing at a rate in excess of other major cities in the county (see Figure 1-2). Beginning with a 1920 population of 26,470 the decennial increases are:

1920-30	77.1%
1930-40	4.2%
1940-50	32.1%
1950-60	26.8%

The population of Clifton increased from 48,827 in 1940 to 64,511 in 1950 and to 81,831 in 1960 or + 32.1% and + 26.8% in each of these decades.

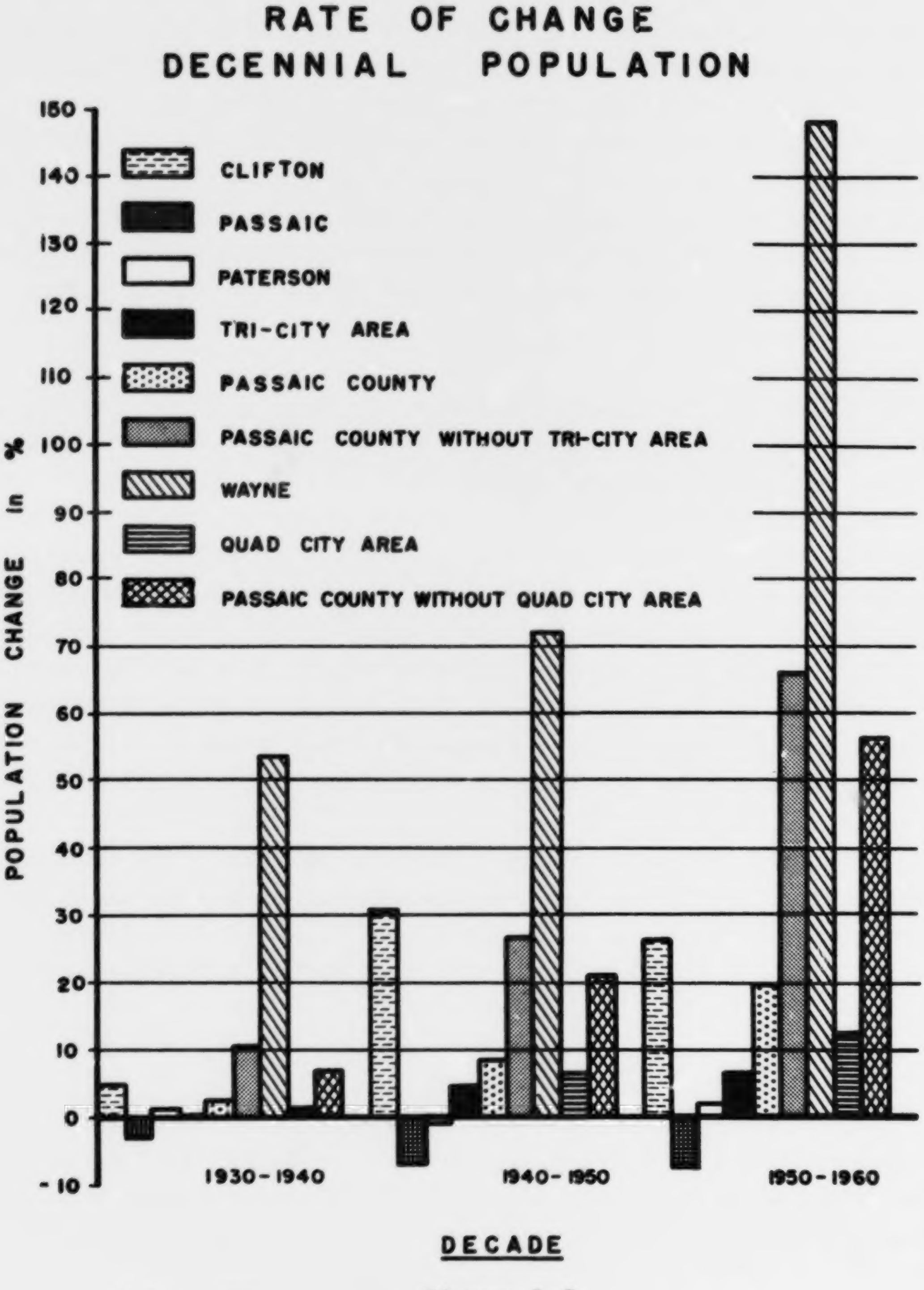

RATE OF CHANGE
DECENNIAL POPULATION
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
POPULATION CHANGE in %
CLIFTON
PASSAIC
PATERSON
TRI-CITY AREA
PASSAIC COUNTY
PASSAIC COUNTY WITHOUT TRI-CITY AREA
WAYNE
QUAD CITY AREA
PASSAIC COUNTY WITHOUT QUAD CITY AREA
1930-1940
1940-1950
1950-1960
DECADE

Figure 1-2

It will be noted, however, that Clifton's growth in the 1950-1960 decade was at about the same rate as Passaic County exclusive of the Tri-City area. In the 1950-1960 decade the "rural" growth far outstripped Clifton with a 67% increase compared to Clifton's increase.

Clifton has developed along the arterial highway system featured by two main highways--Routes 3 and 46. Housing growth in Clifton during this period changed many areas of open land into sub-divisions and built up neighborhoods.

Rapid growth, rapid urbanization and expanding community developed many problems. Growth and development of a community is measured by the number and types of dwelling units, the quality of the housing, and owner occupancy, and the stability of the older neighborhoods. As of 1950, 61% of the dwelling units in Clifton were owner occupied. There are eleven neighborhood areas in the city. The city's land area of 11.2 square miles has an average population density of 11.4 persons per acre.

There is little mixing of single and multi-family houses in the newer areas. Garden apartments are to be found in the community, but no apartment houses. Commercial establishments and industry are primarily light. Clifton has an older portion, and a rapidly growing new portion of the city.

An averaged estimate of the population trend through 1980 indicates that Clifton may reach a population of 101,000 in 1970 and 123,000 in 1980. This population estimate is shown graphically in Figure 1-3.

The City of Clifton has for the most part a generally rolling terrain rising westerly from ten feet at the Passaic River to three hundred feet at Valley Road.

Passaic

The City of Passaic was settled in 1676. Its location on the shores of the Passaic River made it a trading center. In the 1800's industry started to develop throughout the entire area and there was a marked growth as many new immigrants arrived from Central Europe. Passaic was chartered in 1873.

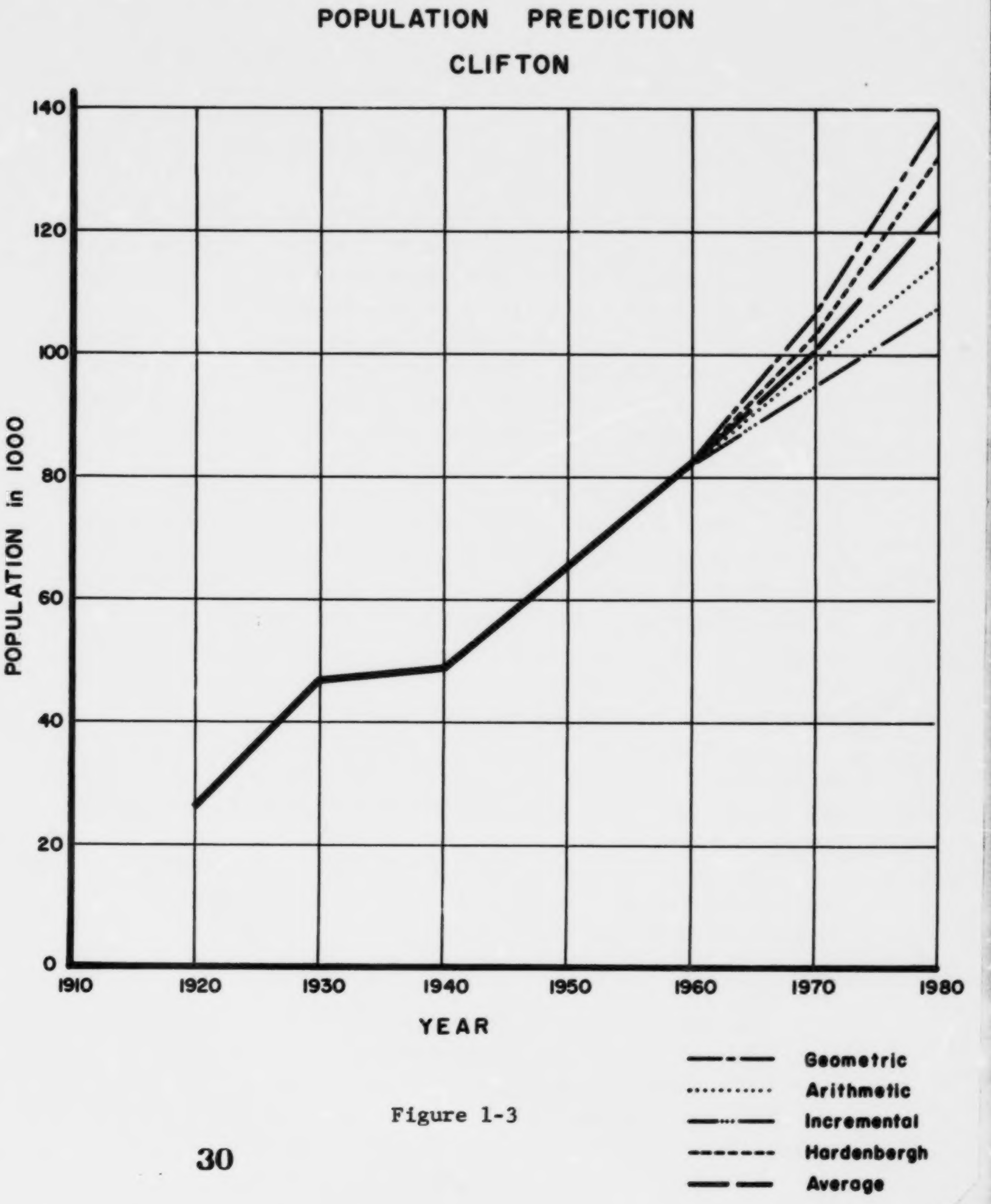

POPULATION PREDICTION
CLIFTON
POPULATION in 1000
140
120
100
80
60
40
20
0
1910
1920
1930
1940
1950
1960
1970
1980
YEAR
Geometric
Arithmetic
Incremental
Hardenbergh
Average

Figure 1-3

Up until the beginning of the 1930's the city grew. After that the city population remained at a level with a slight loss or gain over each decade. During the period of the 1930's the density of the population in Passaic approached 30 per acre. At this density people began to look for less crowded areas for home sites. Thus, after the 20's a decline in the population of Passaic is noted while in the open area of Clifton the population was building up very rapidly. This trend is demonstrated graphically in Figure 1-4.

Passaic was a typical manufacturing town in which the workers in the factories lived within walking distance from the mills. As transportation increased the homes moved out along the trolley and railroad lines and along the bus routes. As the auto became more popular the home sites spread out throughout the city.

At the present time the City of Passaic is about completely built up. It occupies 3.2 square miles and has an average population density of 26.2 persons per acre. There are still a few individual lots available for construction, but if the population density or character of an area is to change it will have to be through a replacement program utilizing multi-family structures or a rehabilitation program in which an area is knocked down and then rebuilt. In either case, multi-story apartment houses would probably be the type of structure built.

Passaic has several areas with multi-story apartments and multi-family dwellings at present.

The traffic problems of the city are similar to those of Clifton. Passaic has a grid work type pattern of streets, however, many are interrupted by the Delaware and Lackawanna Railroad right-of-way. The Erie Railroad right-of-way divides the central business area and interferes with collection routings along Main Avenue. Passaic terrain is rolling but basically flat. The entire city is located on the plain above the Passaic River. The range of elevation in the city is ten feet to 130 feet rising westerly from the Passaic River.

POPULATION PREDICTION

PASSAIC

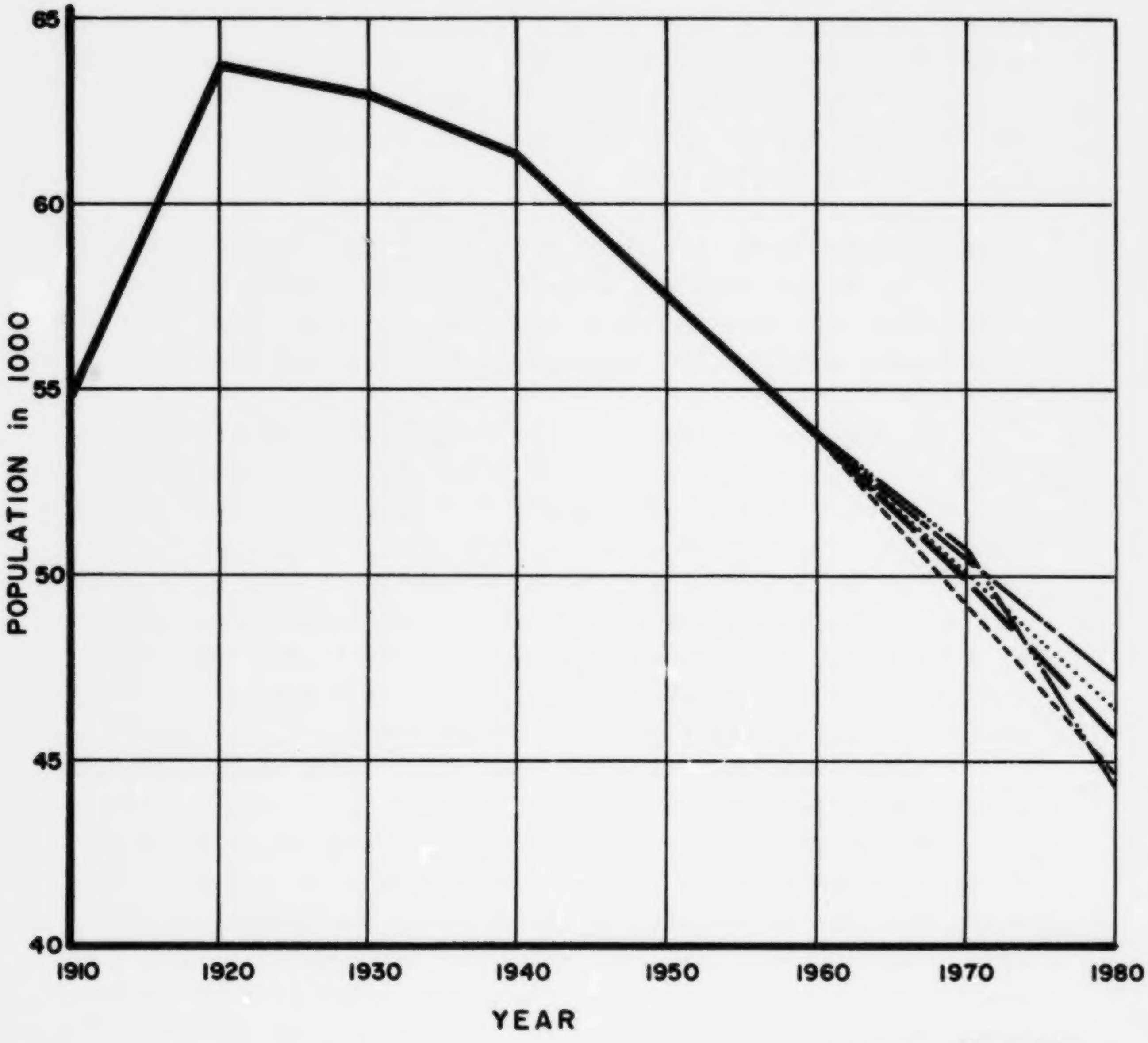


Figure 1-4

Paterson

The City of Paterson was founded in 1791. The site was chosen because of the water power of the Passaic Falls on the Passaic River. Most of the city lies within the large curve of the Passaic River. The remainder lies on high ground to the north of the Passaic River. Paterson was incorporated in 1851 and has had its present form of municipal government since 1907.

In 1840 silk manufacture was introduced to the city and the city shortly thereafter became known as the silk city. Today the silk industry has dropped from 75% of the city's industry to under 30%. Other industries include the manufacture of machinery, machine tools, clothing and chemicals.

As with many older sites which have reached their peak saturation the population begins to drop off. The City of Paterson, with an area of 8.3 square miles, had a population density of 26.8 persons per acre in 1960. This density represents nearly the saturation point for single family houses, and generally signifies the presence of apartment and multi-family houses.

Paterson's growth is without question linked to its industrial growth. Many areas of Paterson have mixed buildings of single family, multi-family, and commercial and industrial uses. Many of the portions of the City of Paterson are being strangled by small and narrow streets which do not permit free movement of the mass of vehicular traffic.

Since industrial employees are more mobile today than they were years ago, many workers are moving from the older urban areas into the newer suburban communities. The population of Paterson is not gaining as rapidly as its sister city Clifton, but has demonstrated a notable increase in the period 1950-1960, as shown in Figure 1-5. It has been estimated that resident population within city boundaries may increase to a maximum of 160,000.

The terrain in Paterson is influenced by the almost canyon like character of the Passaic River which cuts around the high

POPULATION PREDICTION
PATERSON

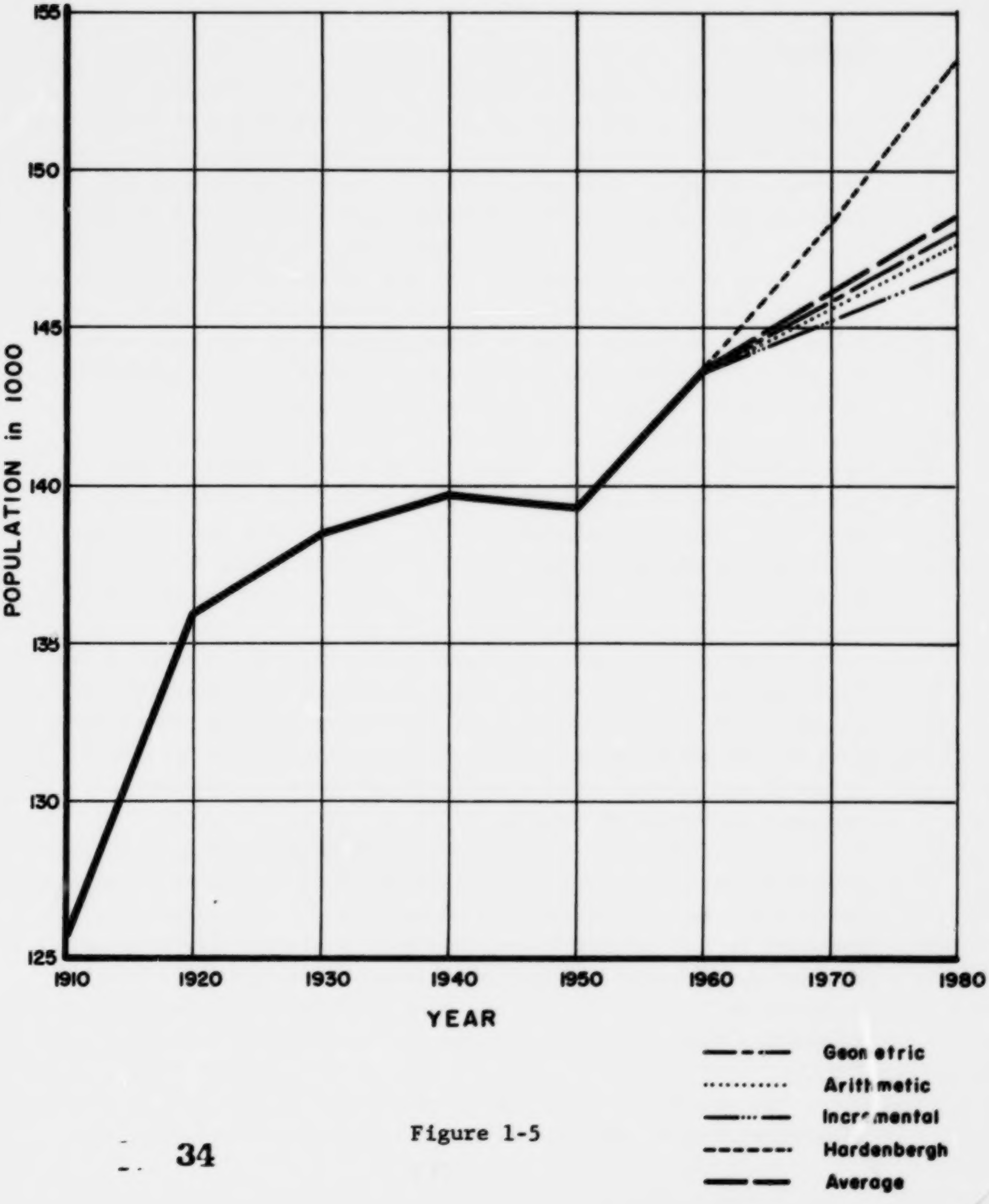


Figure 1-5

rock outcrop known as Garrett Mountain and turns southward forming the easterly boundary of the city. Portions of the city located on the prominence have many dead end streets and steep grades. The plains portion of the city ranges from thirty feet to 150 feet elevation while the high elevations reach 450 feet. The city is cut by the Erie Railroad right-of-way along Railway Avenue.

Wayne

The Township of Wayne was incorporated in 1847 from the division of the then existing Township of Manchester. The township lies in the New York metropolitan area wholly within the County of Passaic situated somewhat to the northwest of the densely populated Tri-City area of Paterson, Passaic and Clifton. The township is actually bounded on the north by the Borough of Pompton Lakes and Bergen County and on the east by the municipalities of North Haledon, Haledon and the Borough of Totowa. The southerly and westerly limits consist of Little Falls, Essex County and Morris County, respectively.

The township consists of approximately 25.7 square miles of which 1.2 square miles consists of water bodies including: Pines Lake, Packanack Lake, Pompton Lake, Pompton River and the Passaic River. The township in 1960 had zoning for 160 miles of roadways. Three major regional highways traverse the municipality. U. S. Route 46 passes through the southern portion, New Jersey Route 23 runs in a north-south direction in the western sector, and the Paterson-Hamburg Turnpike crosses Wayne in a northwest direction between the Borough of Haledon and the Borough of Pompton Lakes. The Garden State Parkway, a road which services the entire eastern section of the State of New Jersey, passes within a few miles of the municipality. There is presently planned an extension of Interstate Route 80 whose right-of-way will pass through the southern tier of the township. A tentative alignment of Interstate Route 287 places this route through the township in a northeast direction from Pompton River.

The topographic characteristics of Wayne Township vary from swampy and alluvial deposits in the flood plains of the Passaic and Pompton Rivers to relatively steep knolls and hills in the northern region.

Wayne was an independent, older, rural type community prior to the first era of suburbanization of the twenties with a sparse population density of 0.12 persons per acre. It was in the twenties that Wayne experienced its first large scale population growth. This was the first period of suburbanization. Although the population has been rapidly expanding since 1920, it was with the dawn of the post World War II period and increasing prosperity in which this municipality experienced its greatest increases in population. Figure 1-6 shows population prediction for the town.

A rapid increase during the 1920-1930 period of 94.2% can be attributed to the overflow of people from the urban areas of Clifton, Passaic and Paterson. During this same period, only the City of Clifton approximated Wayne's rate of growth. Passaic registered a decline in population, Paterson only a minimal percentage increase during the same period, while the county and state experienced a rate of growth of 16 and 28 percent respectively.

Today the community is typically suburban rather than urban in character, a feature attracting large scale growth. The decennial increase from 1950 to 1960 was 17,531, which closely approximated that of Clifton for the same period. This figure far outstrips that of the cities of Passaic and Paterson.

A major impetus to the large scale growth in the community has been due to strategic location along the Paterson-Hamburg Turnpike and its close proximity to U. S. Route 46, New Jersey Route 23 and the Garden State Parkway.

The most recent figures available indicate that the township consists of 13,250 acres of buildable land. Of this total approximately 6,900 acres or 52% of the total buildable land is developed. The present population density on the developed land is 4.40 people per acre and 4.8% of the developed land is devoted to commercial and industrial usage.

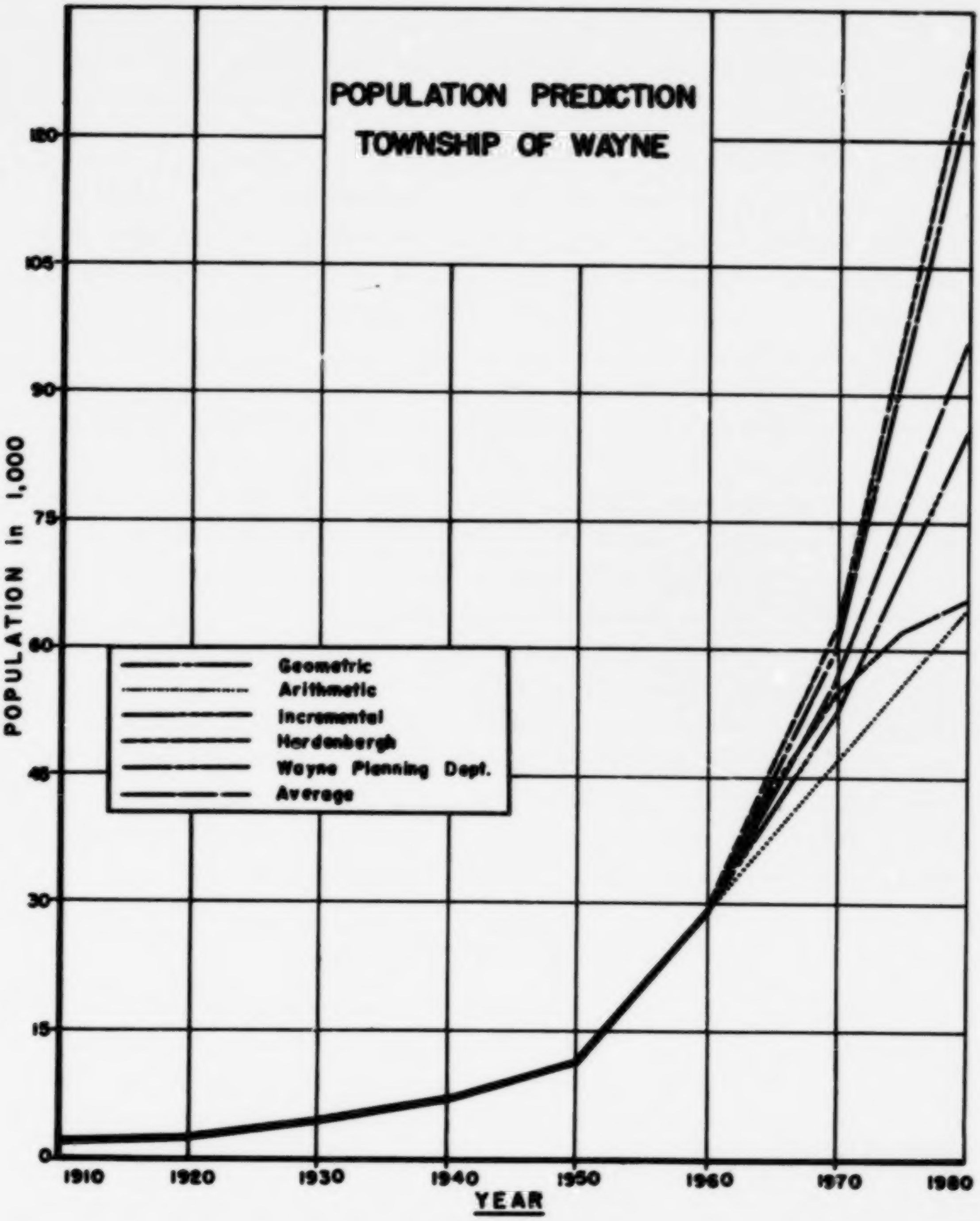

POPULATION PREDICTION
TOWNSHIP OF WAYNE
POPULATION in 1,000
120
105
90
75
60
45
30
15
0
1910
1920
1930
1940
1950
1960
1970
1980
YEAR
Geometric
Arithmetic
Incremental
Hardenbergh
Wayne Planning Dept.
Average

Figure 1-6

Presently, multi-family dwellings are insignificant in the population picture of the township. In 1960 there existed some 8,095 dwelling units of which 7,989 were single family dwellings. There are some garden and duplex apartments in the community, but these constitute only a small fraction of the total.

Population Trends

Table 1-1 is included here to summarize the population growth of the three cities, as well as Wayne and the Quad-City region. The 1960 census population of the total region was 307,255. Estimates of 1970 and 1980 populations are 354,649 and 383,504 respectively.

The Quad-City development can be expected to be comparable with and slightly higher than New Jersey as a whole. The growth should hold evenly over the next two decades. As long as the present trends in suburban living prevail, these projections seem to be well based. There is ample growth area available in Passaic County to continue a growth pattern similar to that of Clifton and Wayne over the last two decades.

Bergen County communities of the region along the Passaic River from Fair Lawn to Lyndhurst total 122,292 population. The Essex County communities of Montclair, Bloomfield and Nutley to the south total 124,429. Thus the regional population in which the Quad-Cities and the Essex County communities are the hub is about 581,700. The population of the Passaic County area alone was about 334,980 in 1960.

Refuse Collection

Each of the four communities is presently collecting refuse independently of the other. Household refuse is collected by contract with scavenger services in Clifton, Passaic and Paterson.

Expiration dates of present contracts in these communities are as follows:

Clifton - 11/30/67
Passaic - 11/30/68
Paterson - 6/30/70

Table 1-1

Quad-City Solid Wastes Project

Population Data
Quad-City Region

Decennial Year	Population Clifton	 Passaic	 Paterson	 Wayne	Quad-City Total
1910		54,773	125,600	2,281	
1920	26,470	63,841	135,875	2,302	228,488
1930	46,875	62,959	138,513	4,469	252,816
1940	48,827	61,394	139,656	6,868	256,745
1950	64,551	57,702	139,336	11,822	273,411
1960	81,831	53,770	142,301	29,353	307,255
1970*	101,114	50,241	146,294	55,000	354,649
1980*	123,254	45,705	148,545	66,000	383,504

*Estimate

Each of these cities is served by a separate scavenger. However, the pattern of operation of each scavenger is similar in the respective cities.

Wayne collection service is quite different in pattern. Under town license, six separate scavengers, forming the Wayne Collection Association, collect refuse and charge households directly in designated areas of the town.

Clifton

Refuse of the city has been collected twice weekly since 1953. Collection of household and commercial refuse is made at the curb. Containers or bundles less than seventy pounds weight will be removed by the regular service.

The contractor is responsible for collection and disposal, and any costs of the latter are included in the contract price.

The city is divided into three districts. District A is collected on Monday and Thursday; District B is collected on Tuesday and Friday; and District C is collected on Wednesday and Saturday.

Material collected includes all categories of refuse except industrial waste. Industrial and commercial refuse is picked up by arrangement between proprietors and private contractors. Private scavengers are not regulated by the city.

The dump site location where refuse collected in Clifton is disposed of is North Arlington.

Passaic

Garbage is collected within the city on a twice weekly routine. All material placed at the curb is collected. There are no requirements about the size or type of container to be placed for refuse storage and ultimate collection.

Passaic Department of Public Works collects boxes, crates, street sweepings, and yard clippings. Passaic Park Department collects limbs, branches, cardboard and trash. Industrial pick up is transported to the Lyndhurst dump by private scavenger.

Paterson

Collection practices in Clifton are applicable in many ways to Paterson.

Refuse collection is on a twice weekly basis in prescribed districts. All material placed out at the curb is collected. Heavy or large bulky objects are collected at routine intervals.

At the present time the contractor collects all domestic refuse within the city but the Department of Public Works picks up street sweepings, debris from fires, and Department construction debris.

All litter baskets on the sidewalks within the confines of the city are collected by the contractor.

Private contracts are entered into by commercial and industrial firms for the removal of wastes. These private scavengers are not supervised by the city.

Wayne

Refuse is collected on a twice weekly basis from approximately 13,000 dwelling units in a community that is approximately 65% developed. There is zoning for approximately 160 multiple dwelling units of the garden apartment type.

Industry of the community is light industrial type. Industrial scavenger service is provided by three scavenger companies in addition to the six mentioned. A schedule has been established, under Ordinance 33, whereby the six licensed collectors pick up residential solid wastes in receptacles amounting in quantity to two bushels or one twenty gallon garbage can per pickup day of lawn clippings and shrubbery, in addition to the garbage. The scavenger is also required to pick up at curb during a week in May and another in October (cleanup weeks), any and all household material without extra charge.

Refuse is taken to disposal sites at Pine Brook in Parsippany-Troy Hills and to Kearny Meadows, Lyndhurst or North Arlington in Bergen County.

Refuse Collection Costs

There are many factors which affect the costs of refuse collection. These include physical conditions, climate, topography, weather, type, length and development of streets, condition of pavement, type of dwellings, zoning, setbacks, the population density, and use of the area by other vehicles and persons. Legal restrictions and the population also affect the cost of refuse collection. The type of container and type of pick up (i.e., curb or door side), the use of home incinerators, garbage grinders, the economic and social levels of the populace, the preparation and segregation of refuse and garbage are all variables influencing the cost of refuse collection.

With so many variables it becomes exceedingly difficult to try to assess the importance of one factor over another as a cause for increase or change in costs.

Table 1-2 presents the actual contract costs for the Cities of Clifton, Passaic and Paterson over the past sixteen years.

Table 1-3 indicates the change in unit cost per capita per year at selected periods, beginning with 1952. Between 1960 and 1966, Passaic had experienced an apparent increase of 18%. The other communities have had from 5.7 to 7.2% increase for the same period.

In 1960 the Cities of Clifton, Passaic and Paterson were provided with a report titled "Technical Report Refuse Collection and Disposal Requirements for Contiguous Communities." This report discusses in detail the technical problems of the three communities. By updating this report with supplemental information on the Township of Wayne, the Quad-City community has been provided with a full background of information on which to proceed. The following pages present many additional data obtained by assay and field investigation. Collectively, these data have become the basis for a comprehensive approach to a practical, economical, and politically acceptable solid wastes handling program at the regional level of operations.

Table 1-2

Quad-City Solid Wastes Project

Refuse Collection Costs
Scavenger Contracts
Clifton - Passaic - Paterson

	Beginning Date	Contract Period Years	Total Cost $	Annual Cost $
Clifton	12/1/50	3	507,000	169,000
	12/1/53	1	158,000	158,000
	12/1/54	2	337,600	168,800
	12/1/56	2	496,000	248,000
	12/1/58	2	468,000	234,000
	12/1/60	3	816,000	272,000
	12/1/63	4	1,258,800	314,700

1966 cost per capita per year = $3.56

Passaic	12/1/51	2	239,000	119,500
	12/1/53	2	250,000	125,000
	12/1/55	2	346,000	173,000
	12/1/57	1	198,900	198,900
	12/1/58	5	993,804	198,761
	12/1/63	5	1,113,800	226,760

1966 cost per capita per year = $4.36

Paterson	7/1/50	3	1,104,000	368,000
	7/1/53	3	1,335,000	445,000
	7/1/56	2	944,000	472,000
	7/1/58	2	1,199,000	599,500
	7/1/60	5	2,989,500	597,900
	7/1/65	5	3,339,000	667,800

1966 cost per capita per year = $4.45

Table 1-3

Quad-City Solid Wastes Project

Unit Costs of Refuse Collection
Quad-City Communities

	1952 Unit Cost $ per Capita per Year	1958 Unit Cost $ per Capita per Year	1960 Unit Cost $ per Capita per Year	1966 Unit Cost $ per Capita per Year	% Increase in Unit Cost 1952 to 1958	% Increase in Unit Cost 1958 to 1960	% Increase in Unit Cost 1960 to 1966
Clifton	2.62	3.08	3.32	3.56[2]	17.6	7.8	7.2
Passaic	2.07	3.28	3.70	4.36[2]	58.4	12.8	17.8
Paterson	2.64	4.08	4.21	4.45[2]	54.5	3.2	5.7
Wayne	--	--	7.07[1]	7.56[2]	--	--	6.9

[1] Based on 1960 Census Figures.

[2] Based on Estimated Population.

SECTION 2

ASSAY PROGRAMS

During the first year's program the highest priority was assigned to the solid wastes assay program. Important objectives of the assay program included determination of: (1) Quantity and composition of solid wastes generated, and (2) Physical and chemical characteristics of the wastes generated.

The assay program comprised four major studies based on wastes generating sources typical to the Quad-City area: (1) Commercial-Residential, (2) Industrial, (3) Construction-Demolition, and (4) Other wastes such as those from clean-up week, street sweepings and other miscellaneous sources.

The procedure for conducting each assay and the important data collected are described in detail in this section.

Community Household and Commercial Solid Wastes

Determination of Solid Wastes Production

Meetings were held with the commissioners of each town to alert them of the impending assay. They, in turn, were asked to inform their respective refuse contractors to cooperate fully with the Quad-City staff, in particular, on the matter of truck weighings. A week prior to the assay, commissioners and contractors were notified again, by mail and personal visit, to outline the desired procedure for truck weighings and truck sampling. The weighing stations were also notified and were asked to keep all weighings of Quad-City trucks in one package to facilitate pick up by the engineer. Constant liaison was kept with the collectors during the assay week.

The total wastes generated by the municipalities during each assay week were obtained by weighing each packer truck contracted to pick up municipal refuse in the Quad-Cities.

In accordance with prior instructions from the Quad-City engineer, the collectors weighed their trucks at certified weighing stations in the proximity of the collectors' route to disposal areas in Bergen and Morris Counties. Those trucks which were selected for sampling at the assay yard were weighed at a certified scale in the proximity of the assay site. After dumping, the trucks made their way back to the scales to provide tare weights. Weighing slips recorded day, time, weight, licence and truck number. Visits were made to the weighing stations each day during the assay week to obtain the weighing slips.

During the following week, the engineer met with the collectors to verify the truck weighings and add any other weighings which may have been missed. The results are shown in Table 2-1 and Figures 2-1 and 2-2 in tons/day for each city and for the Quad-City as a region.

All values except for those from Wayne represent municipal waste production. Wayne collectors pick up industrial as well as residential wastes and that component is reflected in those values. During the first assay week (October 10, 1966), difficulties were experienced in securing separate weighing of trucks in Wayne. Consequently, the estimate by the scavenger contractors servicing Wayne was taken as the waste production. This value is out of line compared with the other two obtained from the second and third assays. The trend over the three assay weeks in Paterson and Clifton shows a decrease in January followed by an upswing in production in May. The highest values were reflected in the October assay.

Municipal production by day of the week is shown in Figure 2-3 with the values adjusted on basis of weekend collection schedules. The tendency is for a rise in production at the middle of the week and gradual decline toward the end.

Assay Procedure

Trucks to be sampled were selected on a random basis. Two trucks were sampled per day, each from a different community. A total of twelve samples were obtained, three from each community. The same two communities were sampled every other day for a

Table 2-1

Quad-City Solid Wastes Project

Solid Waste Production
by
Community and Assay

Community	Production Unit	Assay Week Beginning Oct. 15	 Jan. 23	 May 15	Average
Clifton	Tons/Day	131	94	128	118
Passaic	Tons/Day	69	62	61	64
Paterson	Tons/Day	193	160	202	185
Wayne	Tons/Day	149	73	51	91
Quad-City	Tons/Day	542	389	442	458

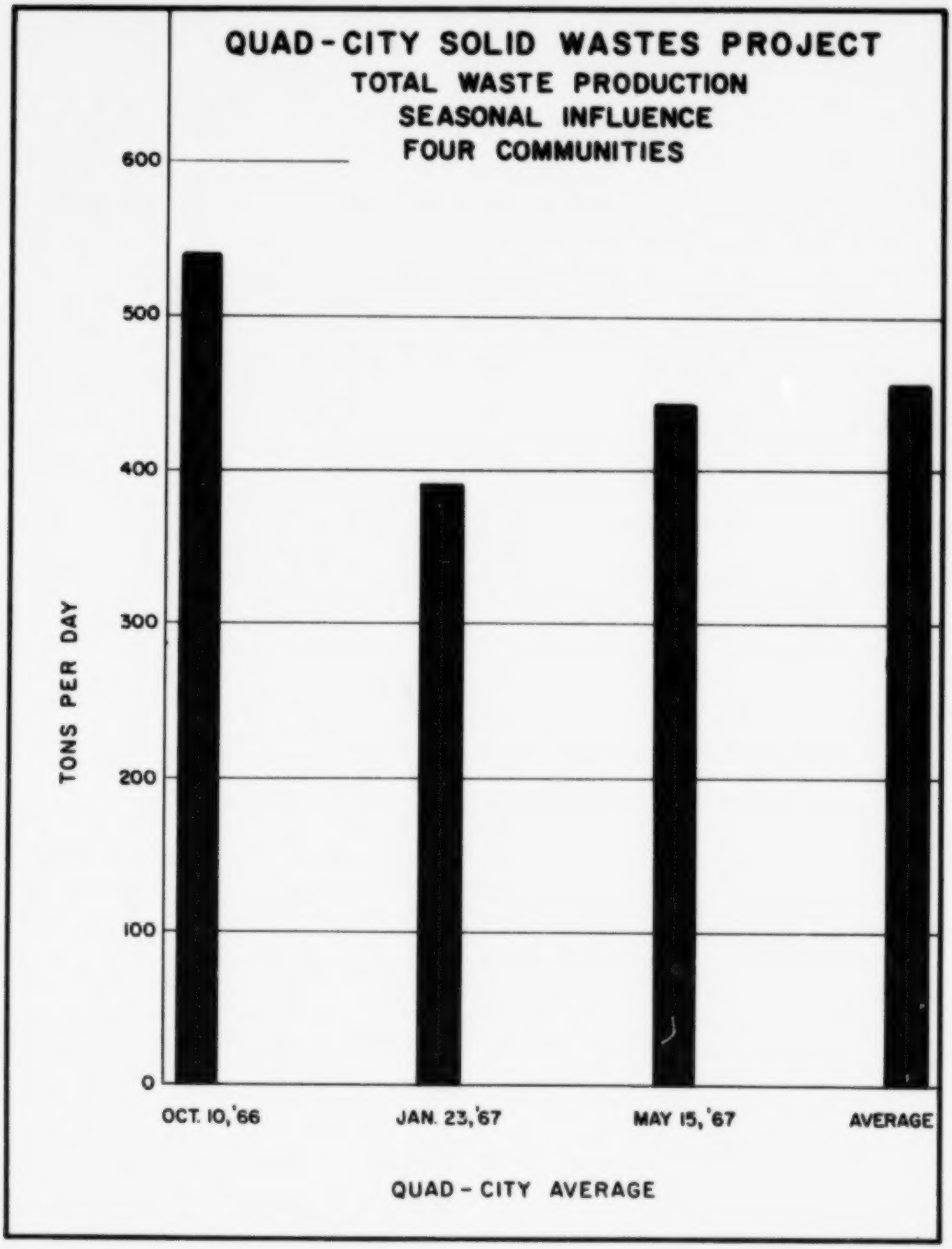

QUAD-CITY SOLID WASTES PROJECT
TOTAL WASTE PRODUCTION
SEASONAL INFLUENCE
FOUR COMMUNITIES
TONS PER DAY
600
500
400
300
200
100
0
OCT. 10,'66
JAN. 23,'67
MAY 15,'67
AVERAGE
QUAD-CITY AVERAGE

Figure 2-1

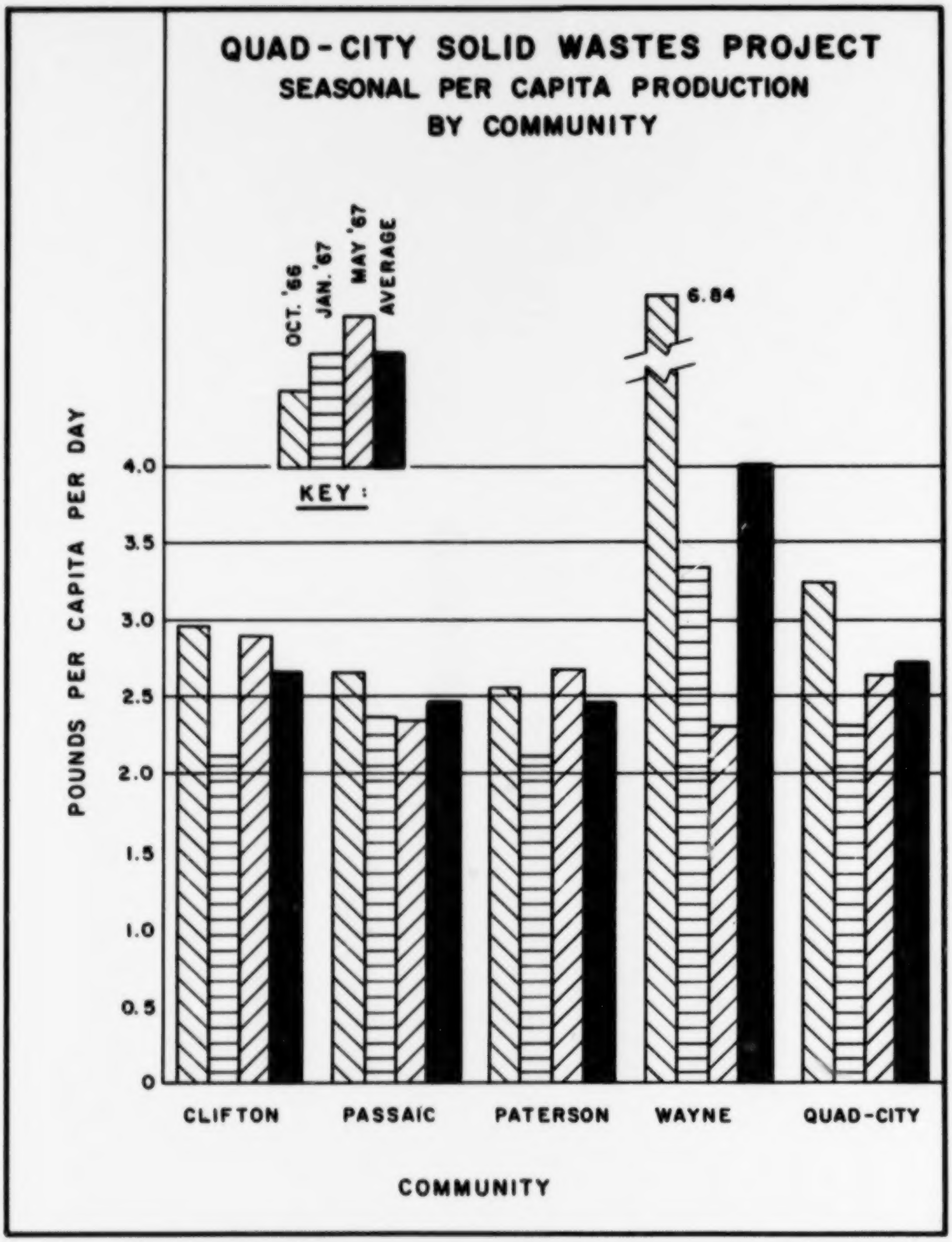

QUAD-CITY SOLID WASTES PROJECT
SEASONAL PER CAPITA PRODUCTION
BY COMMUNITY
OCT. '66
JAN. '67
MAY '67
AVERAGE
KEY:
6.84
POUNDS PER CAPITA PER DAY
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
CLIFTON
PASSAIC
PATERSON
WAYNE
QUAD-CITY
COMMUNITY

Figure 2-2

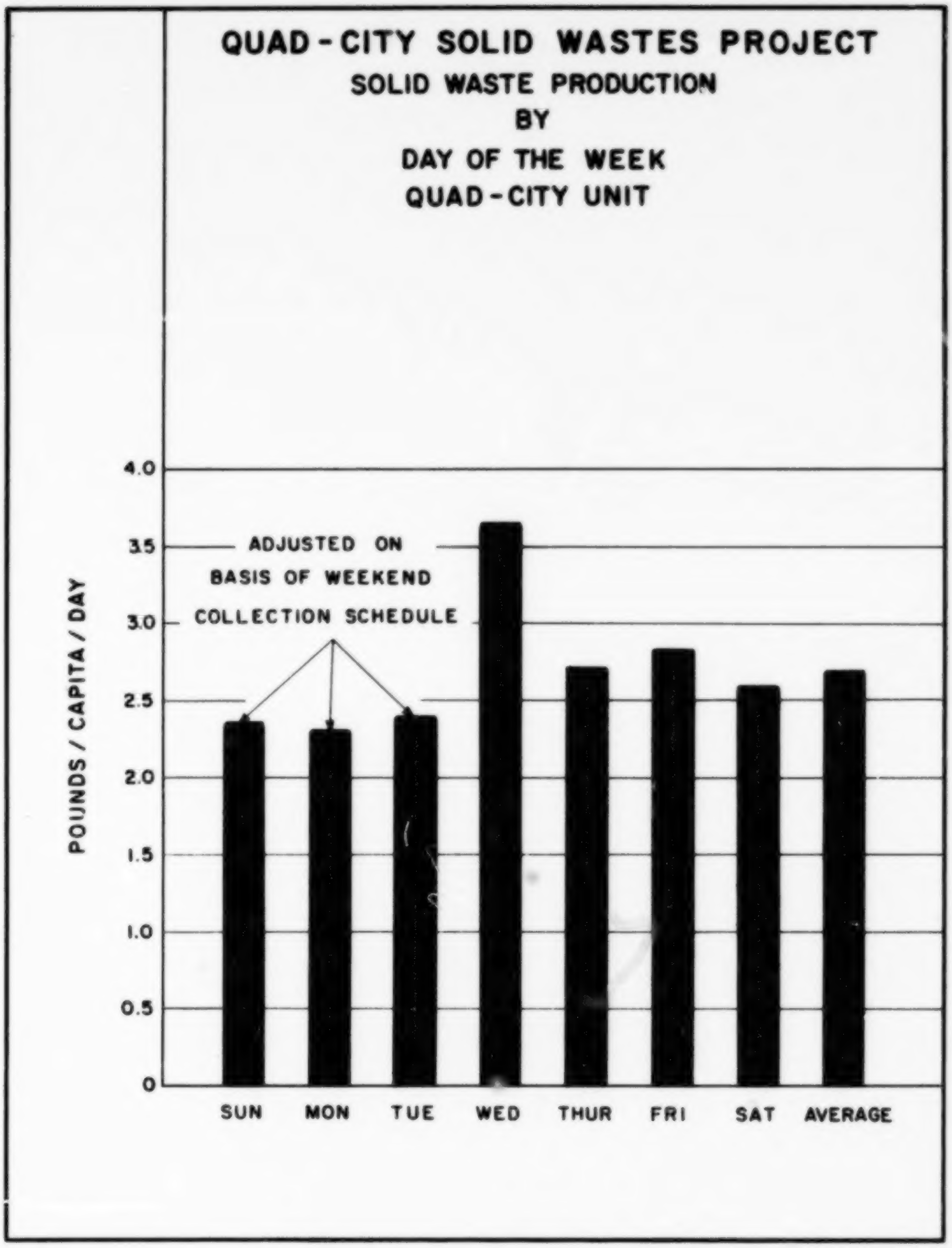

QUAD-CITY SOLID WASTES PROJECT
SOLID WASTE PRODUCTION
BY
DAY OF THE WEEK
QUAD-CITY UNIT
POUNDS / CAPITA / DAY
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
ADJUSTED ON
BASIS OF WEEKEND
COLLECTION SCHEDULE
SUN
MON
TUE
WED
THUR
FRI
SAT
AVERAGE

Figure 2-3

period of six days in the following manner: Paterson and Passaic on Monday, Wednesday and Friday with Clifton and Wayne on Tuesday, Thursday and Saturday.

The packer truck dumped its contents on a non-porous asphalt surface outside the building enclosure. A volume reduction procedure was begun by the front-end loader. For every six loads removed to a 40 cy detachable container for disposal, one was placed on the sampling floor. During this procedure, oversized objects were recorded as to description, number and weight.

When the required sample had been taken from the total load, action moved to the sampling floor where a quartering procedure continued.

The floor in the sampling shed was marked with concentric circles having diameters of 26, 19 and 13 feet respectively, as shown in Figure 2-4. Two diameters at right angles were also painted across the circles.

Also painted nearby were two six foot diameter circles. One of these was subdivided further by two right angled diameters and a concentric four foot circle.

Adjacent to the circles were eight 55 gallon drums and a platform scale of five hundred pound capacity.

The whole operation was supervised by a staff engineer of the Quad-City project with the following complement of men and equipment: One front-end loader with operator and five laborers with sufficient rakes, shovels and brooms.

The sample, at this point, covered the 26 foot diameter circle to a depth of approximately one foot. Due to the bulk of material at this stage, the front-end loader was used to halve the mass. The remaining two quadrants were spread evenly over the 19 foot diameter circle. The front-end loader halved the mass on the opposite side. The remainder was spread by hand-labor, using rakes and shovels, to cover the 13 foot diameter circle to about a one foot depth. At this point, two opposing quadrants, i.e., one and three or two and four, were chosen at random and moved over to two six foot diameter circles. A

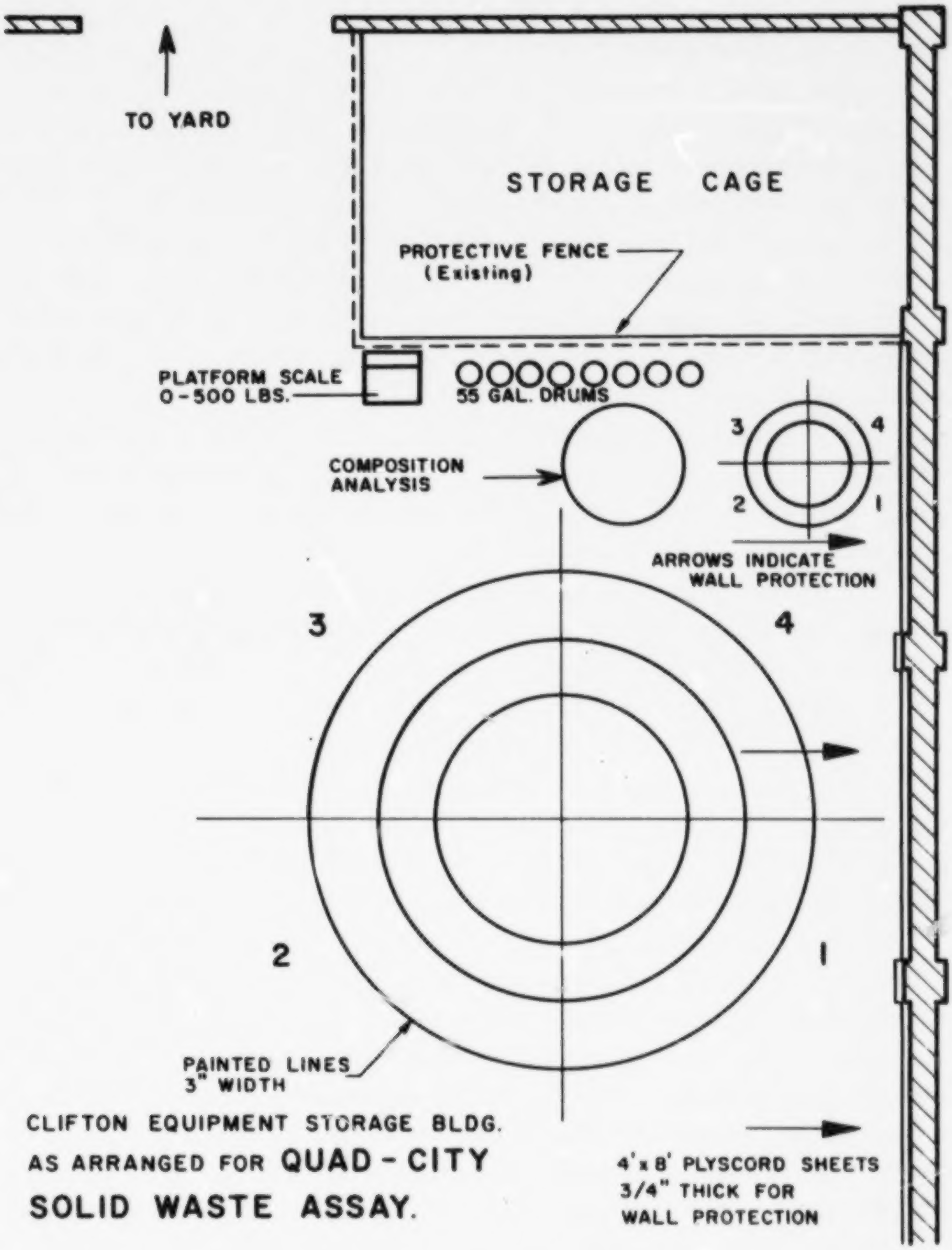

TO YARD
STORAGE CAGE
PROTECTIVE FENCE (Existing)
PLATFORM SCALE 0-500 LBS.
55 GAL. DRUMS
COMPOSITION ANALYSIS
3
4
2
1
ARROWS INDICATE WALL PROTECTION
3
4
2
1
PAINTED LINES 3" WIDTH
CLIFTON EQUIPMENT STORAGE BLDG. AS ARRANGED FOR QUAD-CITY SOLID WASTE ASSAY.
4'x 8' PLYSCORD SHEETS 3/4" THICK FOR WALL PROTECTION

Figure 2-4

composition analysis was performed on one of the circles and the other was broken down further to provide a one cubic foot sample for laboratory analysis.

Composition Analysis

The composition analysis was performed by hand-picking the various types of material and placing them into corresponding containers. There were eight containers used, each having a description of the type of material to be deposited in it. The different materials sorted out are as shown on the sample data sheet in Appendix A2-1, and are as follows:

1. Paper and paper products.
2. Wood and wood products.
3. Plastic, leather and rubber products.
4. Glass and other ceramics.
5. Metal--all kinds.
6. Stone, sand, ash and other inert materials.
7. Organic garbage, leaves, yard clippings, etc.
8. Rags and textile products.

When the sorting was complete, each container was weighed to the nearest pound and the tare weight of each drum subtracted to give the net weight of each type of material.

Figure 2-5 shows the relative percentages of the materials in decreasing order. Paper averaged approximately 45% and organics 22% for the three assays.

One Cubic Foot Sample

The quadrant from which the one cubic foot sample was taken was mixed and spread onto the six foot diameter circle. This mass was then divided into four quarters. Quarters two, three and four were discarded and the remaining quarter mixed and spread over the four foot diameter circle. The mass was halved and the remainder filled a one cubic foot container without compressing. The sample was weighed, tare weight subtracted, and capped to retain moisture. This container was sent to the Consultant for laboratory preparation.

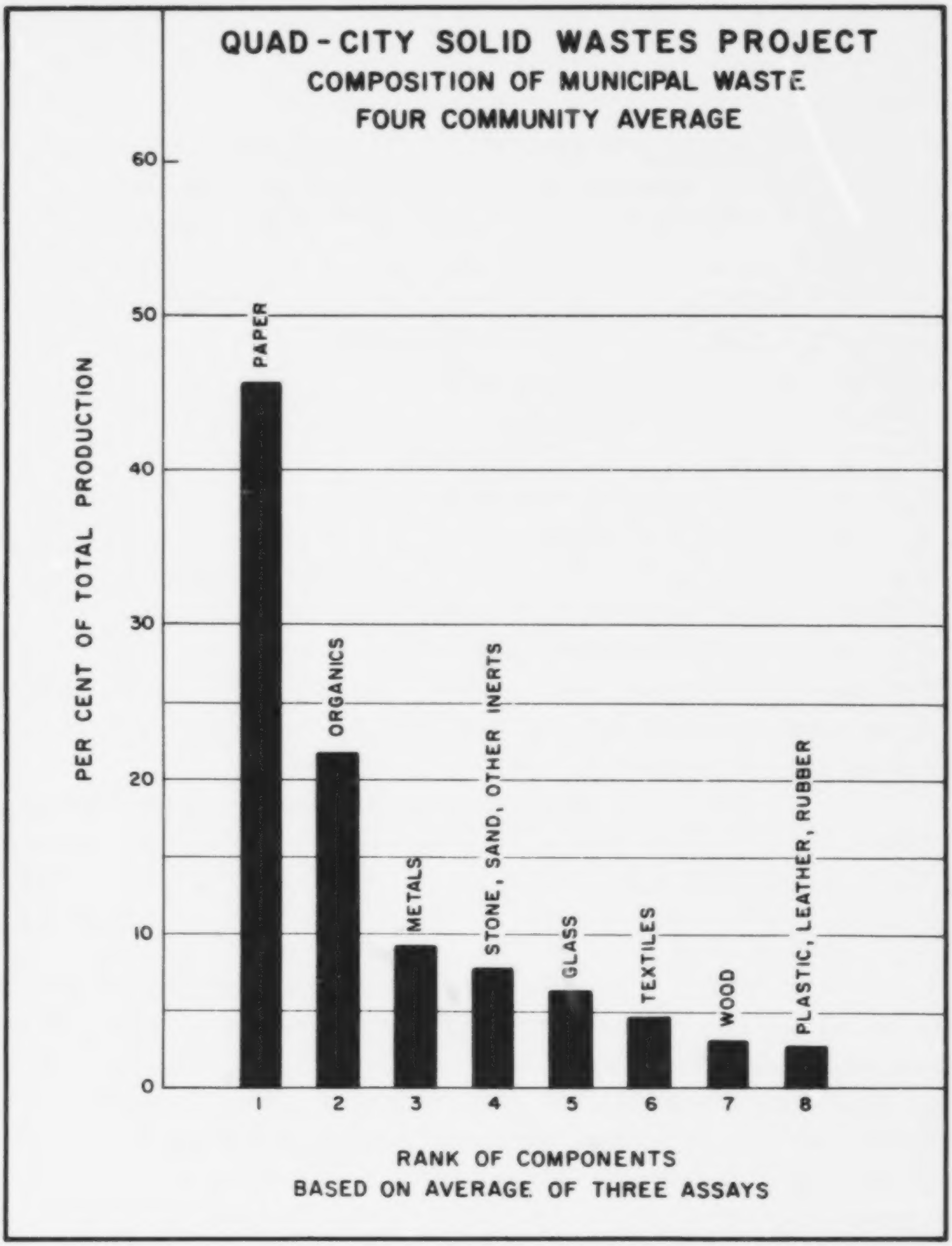

QUAD-CITY SOLID WASTES PROJECT
COMPOSITION OF MUNICIPAL WASTE
FOUR COMMUNITY AVERAGE
PER CENT OF TOTAL PRODUCTION
60
50
40
30
20
10
0
PAPER
ORGANICS
METALS
STONE, SAND, OTHER INERTS
GLASS
TEXTILES
WOOD
PLASTIC, LEATHER, RUBBER
1
2
3
4
5
6
7
8
RANK OF COMPONENTS
BASED ON AVERAGE OF THREE ASSAYS

Figure 2-5

Table 2-2 shows the labor and equipment schedules.

Preparation of Sample for Laboratory Analysis

The one cubic foot sample resulting from the yard assay is then subjected to a smaller scale hand quartering process.

A sheet of stainless steel was prepared as follows:

a) Four concentric circles varying from six inches to two feet in diameter were scribed.

b) The circles were then divided into quadrants by scribing two diameters, the second ninety degrees from the first.

c) The quadrants were numbered one to four.

The sample was then dumped onto the sheet, and all inert objects such as metal, glass and stone were removed. These inert objects were carefully cleansed so that only inerts were being removed, combustible material being returned to the sample. The inert objects were then weighed in total and the results recorded. The garbage was then thoroughly mixed and leveled to the two foot circle. This mass was then divided into four quarters. If necessary, objects which straddled quarter boundaries were cut with shears. Quarters one and three were discarded and the remaining two were mixed and leveled as before using the appropriate circle as a guide. At this point, quarters two and four were discarded. Mixing and leveling were repeated and quarters one and three discarded. Finally, after mixing again, quarters two and four were discarded. The remainder was bottled for dispatch to the laboratory. The volume at this point had been reduced to one liter. Scheduling of this quartering procedure is shown in Table 2-3.

At the laboratory the sample as submitted was analyzed for carbon and nitrogen. Moisture, volatiles and ash were determined. BTU was obtained by standard bomb calorimeter methods.

Percentage inerts in the sample was calculated. The laboratory results were reported on an as received basis accounting for moisture, carbon, nitrogen, volatiles and ash on percentage basis and BTU per pound. Also, the results were reported on a

Table 2-2

Quad-City Solid Wastes Project

Assay Quartering Procedure
Labor and Equipment Schedules

Labor

1 - Operator (front-end loader)

5 - Material handlers

1 - Driver (truck)

1 - QCSWC engineer

Equipment

1 - Front-end loader

2 - 40 cy detachable containers

1 - Platform scale (0-500#)

8 - 55 gallon drums

12 - One cubic foot containers with caps

Rakes, shovels, brooms

Table 2-3

Quad-City Solid Wastes Project

Schedule
Laboratory Sample Preparation

Step	Action
1	Remove recognizable noncombustible items of glass, metal and stone.
2	Mix and spread sample. Separate into quarters and remove quarters 1 and 3.
3	Mix and spread sample. Separate into quarters and remove quarters 2 and 4.
4	Mix and spread sample. Separate into quarters and remove quarters 1 and 3.
5	Mix and spread sample. Separate into quarters and remove quarters 2 and 4.
6	Place quarters 1 and 3 into sample bottle for laboratory analysis.

dry basis recording carbon, nitrogen, volatiles and ash by percent and BTU per pound.

The final estimate of BTU per pound and percent of moisture, volatiles and inerts was determined by calculation. The Consultant's estimate of the probable values derived from those calculations is reported in Table 2-4 and Figures 2-6 and 2-7 and 2-8. The Quad-City community municipal waste as collected during the assay periods was estimated at 3,360 BTU/#.

The Industrial Survey

An industrial survey was performed to determine the amount and type of refuse being generated by industry in the Quad-City region. Individual industries were identified through the use of the New Jersey State Industrial Directory which lists industry according to a Standard Industrial Code (SIC). SIC listings were consolidated into more broad based categories applicable to Quad-City industry. Eleven classifications were selected as follows:

Metal
Paper
Textiles
Plastics
Food
Wood
Rubber
Chemicals
Glass
Leather
Miscellaneous

An industrial questionnaire was developed for use during plant visits. The format of the questionnaire was as follows: Identification of the plant, i.e., location and type of operation, names and titles of people furnishing information, amount of waste production and an estimate of types of waste material by class. A description of waste handling and methods of disposal was included as well as an estimate of solid waste handling costs (see Appendix A2-2). Chamber of Commerce representatives of the four communities assisted the project by encouraging industrial cooperation.

As a first objective, it was decided that not less than 20% of the plants in a specific category in a given community would be included in the survey. Table 2-5 and Figure 2-9 show

Table 2-4

Quad-City Solid Wastes Project

Estimated BTU
from
Adjusted Assay Data*
by Community

Adjusted Field Material	BTU per Pound				
	Weighted Average 3 Assays	Assay			Average Assay 2 & 3
		1	2	3	
PATERSON					
As Collected	3,498	3,400	3,298	3,829	3,564
Dry Basis	5,737	4,653	6,136	6,783	6,460
CLIFTON					
As Collected	3,155	2,803	2,577	4,085	3,331
Dry Basis	5,011	4,493	4,087	6,454	5,270
PASSAIC					
As Collected	3,638	2,822	1,887	6,206	4,046
Dry Basis	6,655	5,170	4,248	10,546	7,397
WAYNE					
As Collected	3,136	2,778	3,600	3,029	3,314
Dry Basis	6,451	5,571	7,035	6,748	6,892
QUAD-CITY					
As Collected	3,360	2,985	2,840	4,287	3,564
Dry Basis	5,957	4,947	5,376	7,633	6,504

*Note: Assays 2 & 3 have been adjusted to compensate for inerts removed from sample before laboratory analysis. Assay 1 adjustments computed from assay 2 & 3 average data.

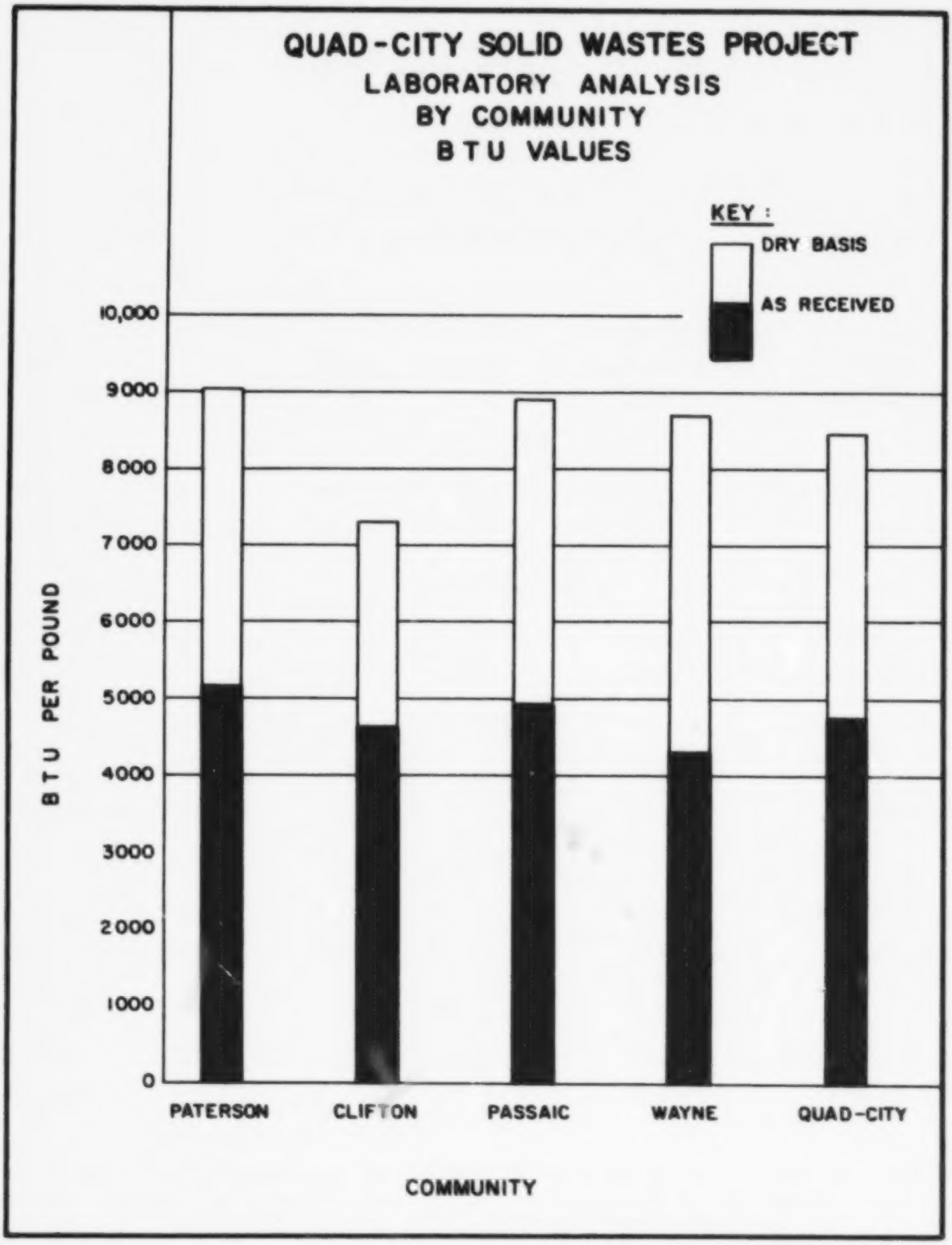

QUAD-CITY SOLID WASTES PROJECT
LABORATORY ANALYSIS
BY COMMUNITY
BTU VALUES
KEY:
DRY BASIS
AS RECEIVED
BTU PER POUND
10,000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
PATERSON
CLIFTON
PASSAIC
WAYNE
QUAD-CITY
COMMUNITY

Figure 2-6

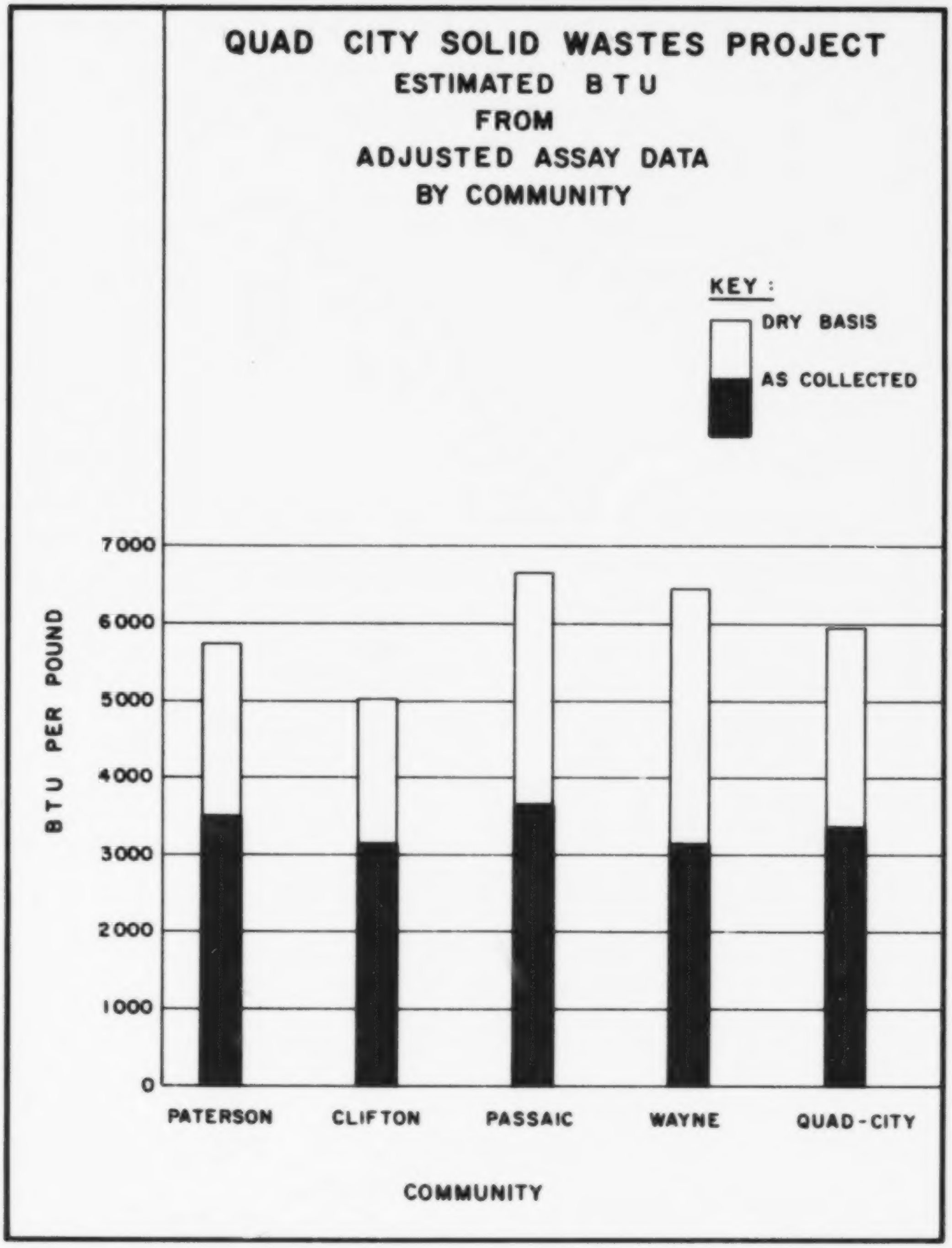

QUAD CITY SOLID WASTES PROJECT
ESTIMATED BTU
FROM
ADJUSTED ASSAY DATA
BY COMMUNITY
KEY:
DRY BASIS
AS COLLECTED
BTU PER POUND
7000
6000
5000
4000
3000
2000
1000
0
PATERSON
CLIFTON
PASSAIC
WAYNE
QUAD-CITY
COMMUNITY

Figure 2-7

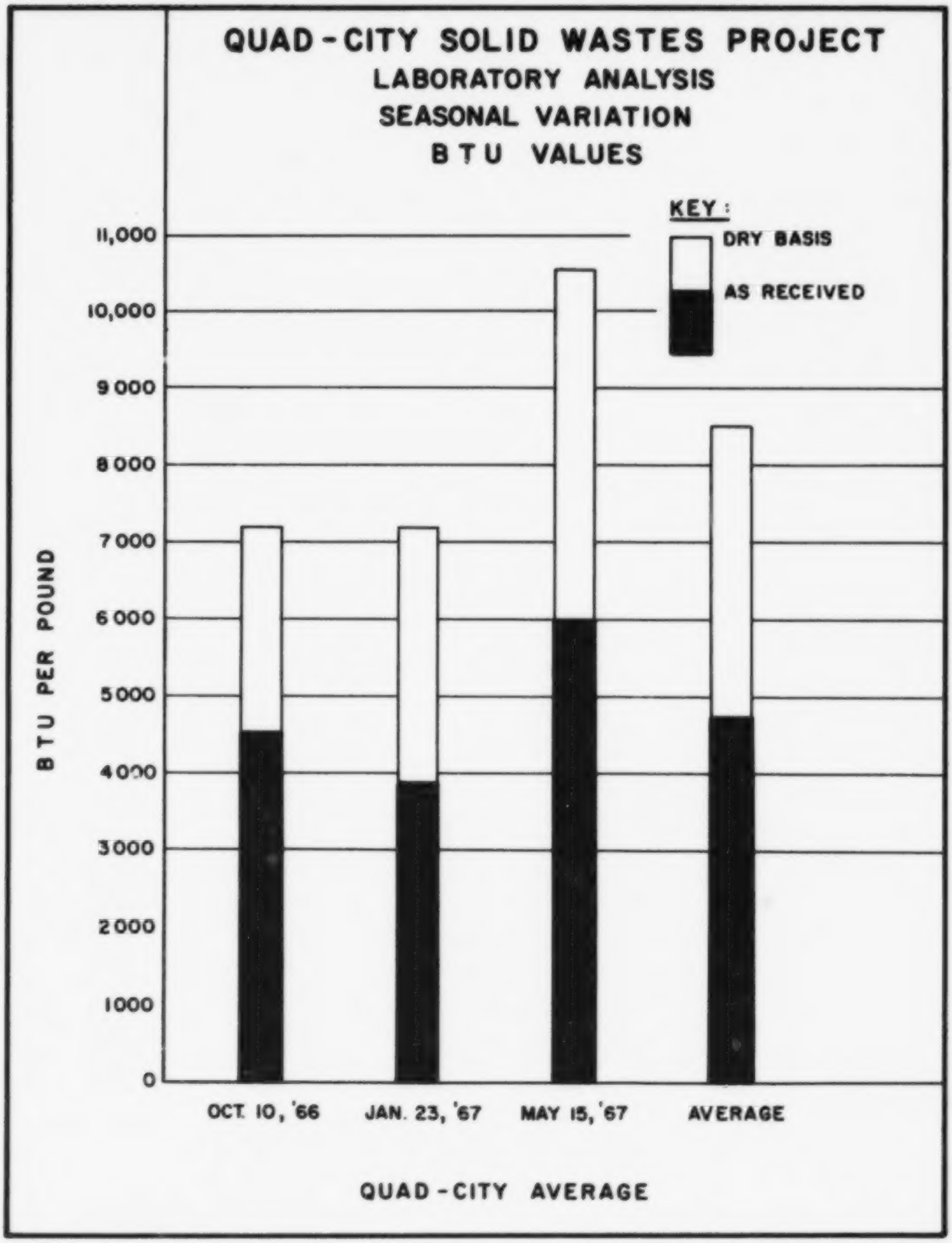

QUAD-CITY SOLID WASTES PROJECT
LABORATORY ANALYSIS
SEASONAL VARIATION
BTU VALUES
KEY:
DRY BASIS
AS RECEIVED
BTU PER POUND
11,000
10,000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
OCT. 10, '66
JAN. 23, '67
MAY 15, '67
AVERAGE
QUAD-CITY AVERAGE

Figure 2-8

Table 2-5

Quad-City Solid Wastes Project

Industrial Inventory
by
Classification of Wastes
Four Communities

Category	No. Plants in Category	No. Plants Surveyed	% of Total
Metals	298	99	33
Paper	76	24	32
Textiles	376	80	21
Plastics	49	22	45
Food	32	13	41
Wood	30	11	37
Rubber	14	7	50
Chemicals	74	29	39
Glass	35	18	51
Leather	10	2	20
Misc.	39	17	44
Totals	1033	324	31

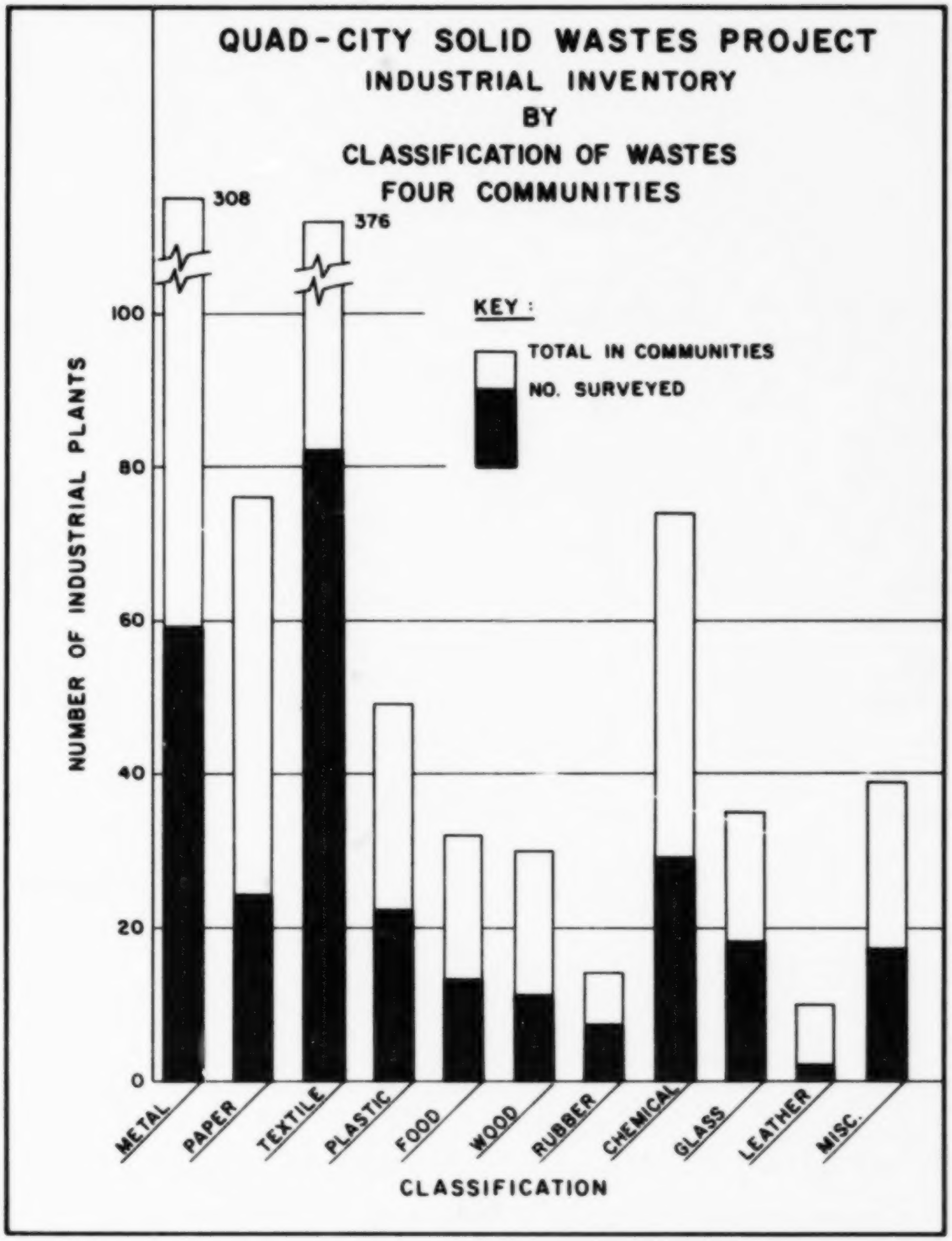

QUAD-CITY SOLID WASTES PROJECT
INDUSTRIAL INVENTORY
BY
CLASSIFICATION OF WASTES
FOUR COMMUNITIES
KEY:
TOTAL IN COMMUNITIES
NO. SURVEYED
308
376
NUMBER OF INDUSTRIAL PLANTS
0
20
40
60
80
100
METAL
PAPER
TEXTILE
PLASTIC
FOOD
WOOD
RUBBER
CHEMICAL
GLASS
LEATHER
MISC.
CLASSIFICATION

Figure 2-9

the number of plants in category for the Quad-City region and the corresponding number of plants surveyed. Figures 2-10, 2-11, 2-12 and 2-13 present the same information for each community. The percent surveyed was well above 20% in most cases.

At each plant interviews were conducted with responsible production-line people such as a plant manager or plant foreman. The plant processes were discussed and waste materials were examined by a Quad-City engineer. Collection and storage areas where waste materials were placed until disposed of were inspected and estimates of quantity and types of materials were made by the engineer and the plant manager. The type of disposal such as by private scavenger, on-site incineration, or carting by the owner was ascertained. Details of the ultimate disposal site were obtained, i.e., location and type of disposal. Cost figures were provided by the purchasing agent.

Since most of the data obtained was in terms of volume, densities of various types of materials were obtained in the field as part of the assay program or from manuals such as the AISC Handbook. A list of the densities used is given in Table 2-6.

Data were converted to tons per day and the total waste material generated by the 324 plants surveyed was calculated to be approximately 250 tons/day.

The inventory shows that over 75% of the industrial solid wastes produced in the four communities is being disposed of on landfills in Bergen County. Table 2-7 provides a list by industrial category, showing disposition of waste material from surveyed industry to landfills. Bergen County receives waste material from 81% of the industries surveyed. Two percent use sites in Passaic County, while 8% use sites in Morris County. Nine percent that dispose to other areas are industries disposing wastes to unidentified locations.

It was found that 179 tons per day of solid waste now go to landfill from the plants surveyed in this inventory. The distribution was 85.3% to Bergen County, 0.4% to Passaic County,

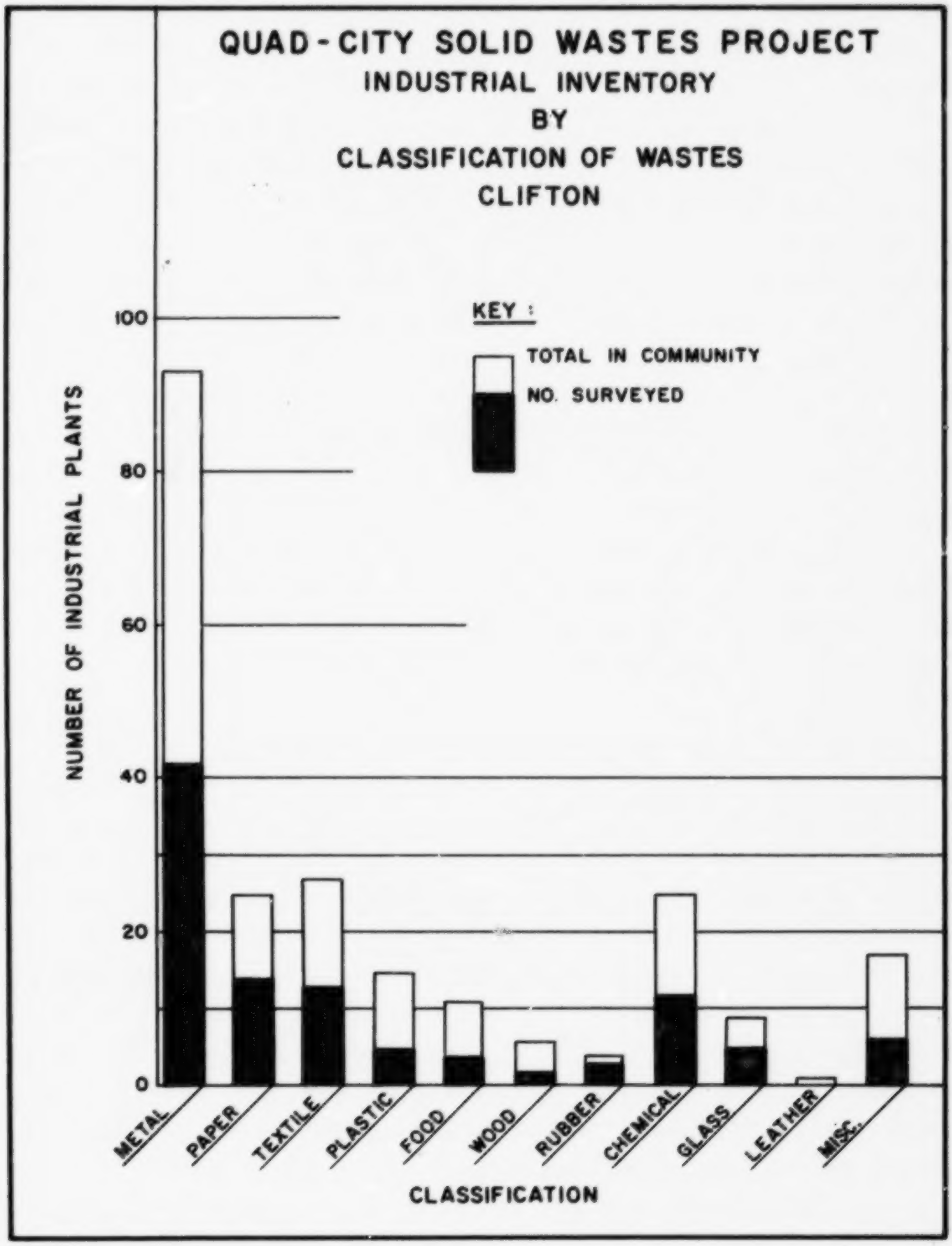

QUAD-CITY SOLID WASTES PROJECT
INDUSTRIAL INVENTORY
BY
CLASSIFICATION OF WASTES
CLIFTON
KEY :
TOTAL IN COMMUNITY
NO. SURVEYED
NUMBER OF INDUSTRIAL PLANTS
100
80
60
40
20
0
METAL
PAPER
TEXTILE
PLASTIC
FOOD
WOOD
RUBBER
CHEMICAL
GLASS
LEATHER
MISC.
CLASSIFICATION

Figure 2-10

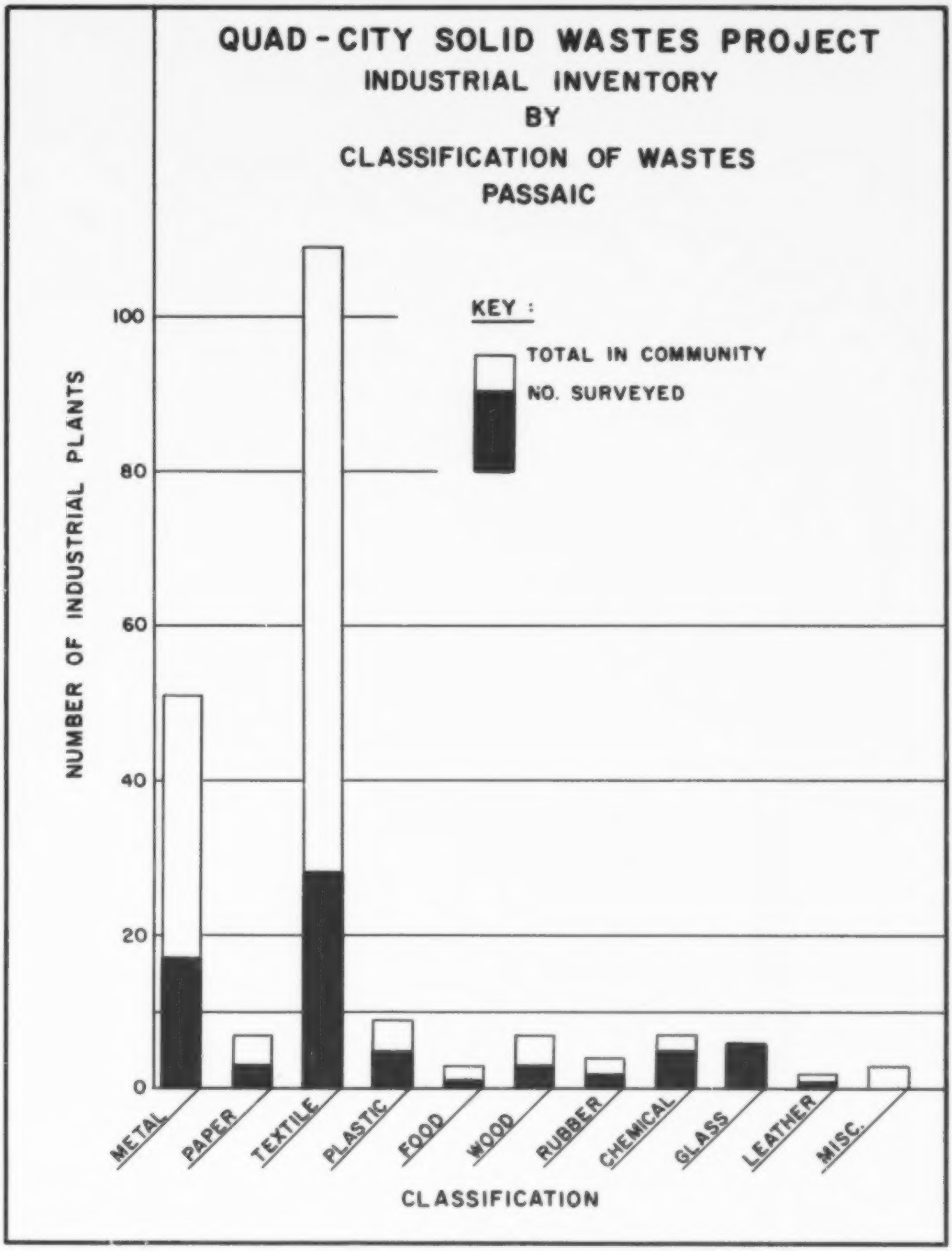

QUAD-CITY SOLID WASTES PROJECT
INDUSTRIAL INVENTORY
BY
CLASSIFICATION OF WASTES
PASSAIC
KEY :
TOTAL IN COMMUNITY
NO. SURVEYED
NUMBER OF INDUSTRIAL PLANTS
100
80
60
40
20
0
METAL
PAPER
TEXTILE
PLASTIC
FOOD
WOOD
RUBBER
CHEMICAL
GLASS
LEATHER
MISC.
CLASSIFICATION

Figure 2-11

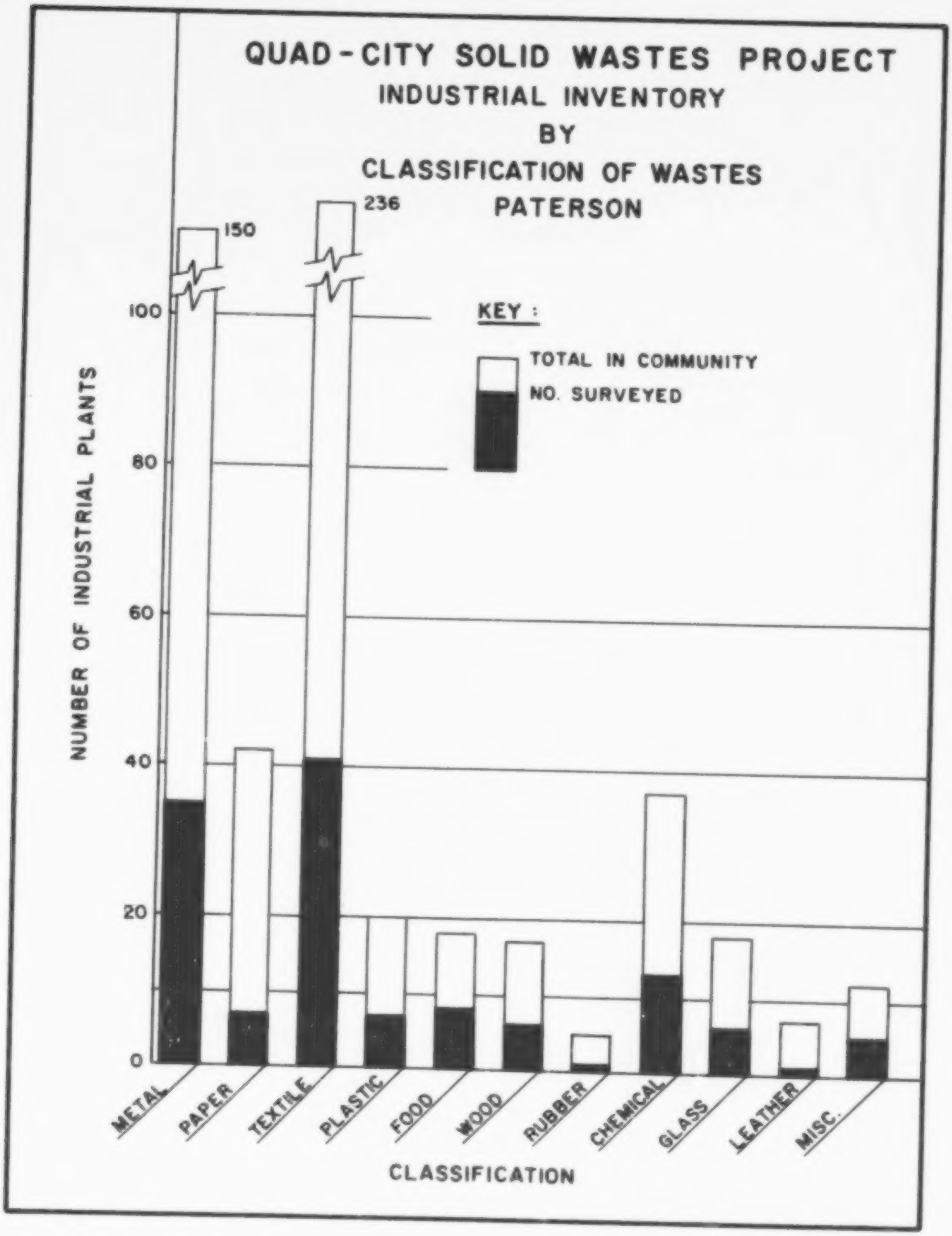

QUAD-CITY SOLID WASTES PROJECT
INDUSTRIAL INVENTORY
BY
CLASSIFICATION OF WASTES
PATERSON
KEY :
TOTAL IN COMMUNITY
NO. SURVEYED
150
236
NUMBER OF INDUSTRIAL PLANTS
0
20
40
60
80
100
METAL
PAPER
TEXTILE
PLASTIC
FOOD
WOOD
RUBBER
CHEMICAL
GLASS
LEATHER
MISC.
CLASSIFICATION

Figure 2-12

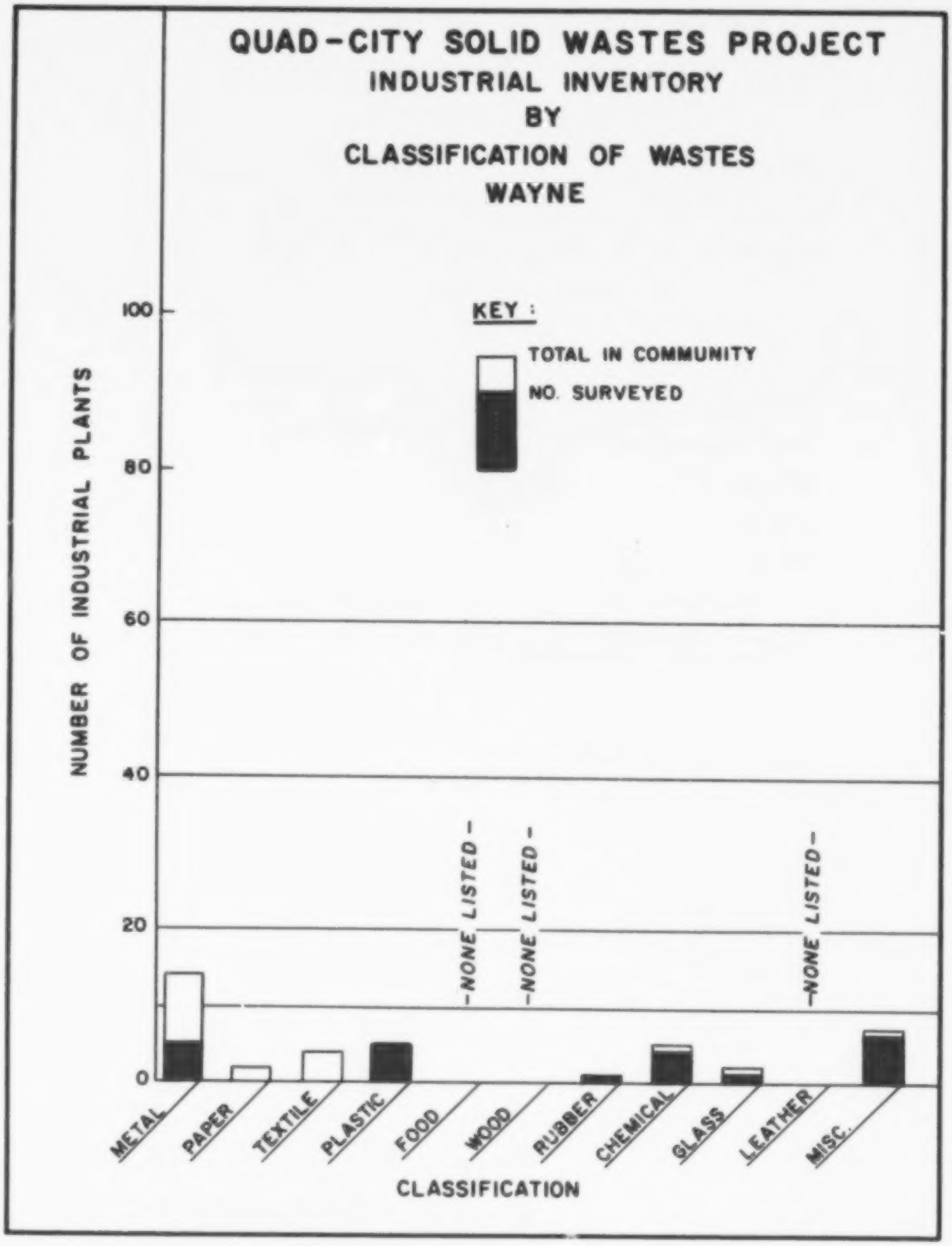

QUAD-CITY SOLID WASTES PROJECT
INDUSTRIAL INVENTORY
BY
CLASSIFICATION OF WASTES
WAYNE
KEY:
TOTAL IN COMMUNITY
NO. SURVEYED
NUMBER OF INDUSTRIAL PLANTS
100
80
60
40
20
0
-NONE LISTED-
-NONE LISTED-
-NONE LISTED-
METAL
PAPER
TEXTILE
PLASTIC
FOOD
WOOD
RUBBER
CHEMICAL
GLASS
LEATHER
MISC.
CLASSIFICATION

Figure 2-13

Table 2-6

Quad-City Solid Wastes Project

Densities of Waste Materials

Material	Density lbs/cy
Paper	235
Cinders	1514
Metals (tin cans)	439
Rags	196
Plastic	101
Garbage	211
Wet paper	277
Glass	740
Wood	150
Rubber	450
Petroleum	1350
Mixed Chemical	300

Table 2-7

Quad-City Solid Wastes Project

Disposition of Industrial Waste
to
Sanitary Landfill Disposal

	Number of Surveyed Industries Discharging to Landfill Locations			
Category	Bergen County	Passaic County	Morris County	Other
Metal	70	3	7	11
Paper	18	-	-	4
Textiles	68	1	2	4
Plastics	16	-	4	2
Food	13	-	1	-
Wood	8	-	1	2
Rubber	7	-	-	-
Chemical	23	-	3	2
Glass	15	1	1	2
Leather	2	-	-	-
Misc.	9	-	5	2
Total	249	5	24	29
Percent	81%	2%	8%	9%

11.5% to Morris County and 2.8% to other unidentified sites (see Table 2-8).

Table 2-9 and Figures 2-14 and 2-15 show the amounts and relative percentages of different types of material found in the total waste produced among industries surveyed. Paper, by far, the greatest amount of waste material being generated amounted to 108 tons/day or 42.7%. Plastic material was in second place, with 31.9 tons/day or 12.6%.

Estimate of Industrial Waste Production

Industrial waste production in each of the eleven industrial classifications described previously was totalled for industries in each community (see Figures 2-16, 2-17, 2-18 and 2-19). Totals for the four communities as a unit are shown in Table 2-10 and Figure 2-20 according to class of material. The industries surveyed represent 31% of the total industry in the Quad-Cities.

The relationship between surveyed plants and total number in communitiy is shown in Figure 2-21. Total production obtained for the industries surveyed was used to estimate waste production for the entire industry in each community and for Quad-City as a unit. The following procedure was used to determine total industrial waste production.

The totals, in lbs/day, for each classification by community, were determined for a 7-day week for those industries surveyed. These data were expressed on a per capita basis by dividing the population of each community into its industrial waste output by class. Population from 1960 census were used.

The factual data obtained from those plants surveyed was then projected to the entire industrial community in each city and expressed in #/capita/day as shown in Table 2-11 and Figure 2-22. The unit figures were multiplied by the ratio of total industries in classification by community to total number of industries surveyed by community

$$\frac{i_{TC}}{i_{SC}}$$

Table 2-8

Quad-City Solid Wastes Project

Quantity of Industrial Waste Disposed of in Landfill

Category	Landfill Locations Disposal in Pounds per Day Bergen County	Passaic County	Morris County	Other	All Sites
Metal	68,865	263	1,660	2,783	73,571
Paper	37,679			1,307	38,986
Textile	32,362		446	956	33,764
Plastics	37,102		13,900	2,857	53,859
Food	10,149		857		11,006
Wood	6,709		286	643	7,638
Rubber	17,175				17,175
Chemicals	58,479		1,228	65	59,772
Glass	26,017	1,098	571	714	28,400
Leather	489				489
Misc.	10,301		22,104	838	33,243
Totals	305,327	1,361	41,052	10,163	357,903
% of Total	85.3	0.4	11.5	2.8	100

Table 2-9

Quad-City Solid Wastes Project

Industrial Waste Study
Composition of Industrial Waste
Among Industries Surveyed

Type Material	Amount Produced* tons/week	tons/day	Percent
Paper	540.63	108.13	42.73
Wood	92.89	18.58	7.34
Plastic	159.48	31.90	12.61
Glass	38.31	7.66	3.03
Metal	56.65	11.33	4.48
Stone, Sand	64.32	12.86	5.09
Organic Chemicals	42.08	8.42	3.32
Textiles	41.51	8.30	3.28
Rubber	19.93	3.99	1.57
Ceramics	2.43	0.49	0.19
Inorganic Chemicals	2.92	0.58	0.23
Petro-Chemicals	31.04	6.21	2.45
Mixed Commercial	52.70	10.54	4.15
Food	63.23	12.65	5.00
Miscellaneous	57.32	11.46	4.53
Total	1265.44	253.10	100.00

*Based on 5-day week.

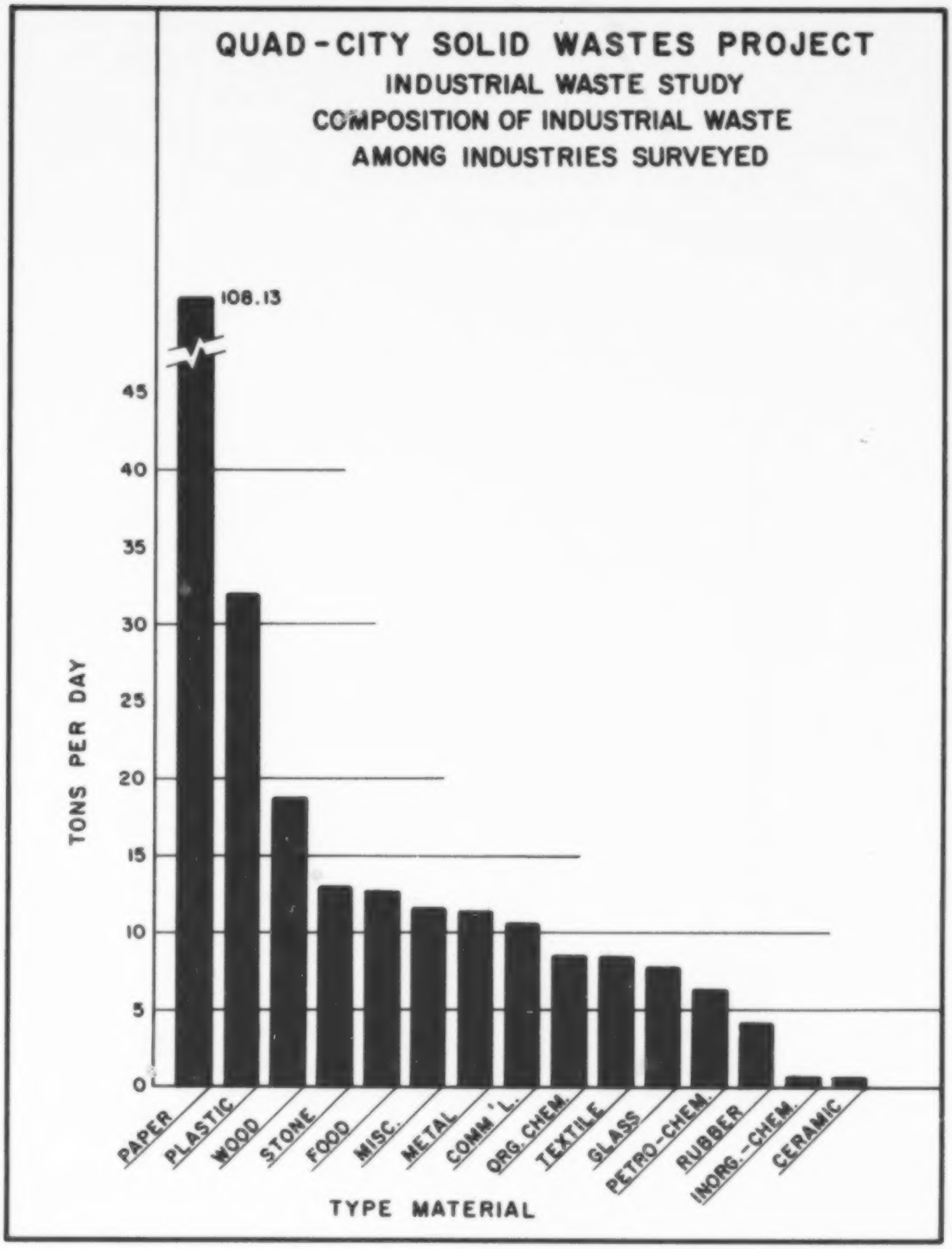

QUAD-CITY SOLID WASTES PROJECT
INDUSTRIAL WASTE STUDY
COMPOSITION OF INDUSTRIAL WASTE
AMONG INDUSTRIES SURVEYED
108.13
TONS PER DAY
0
5
10
15
20
25
30
35
40
45
PAPER
PLASTIC
WOOD
STONE
FOOD
MISC.
METAL
COMM'L.
ORG. CHEM.
TEXTILE
GLASS
PETRO-CHEM.
RUBBER
INORG.-CHEM.
CERAMIC
TYPE MATERIAL

Figure 2-14

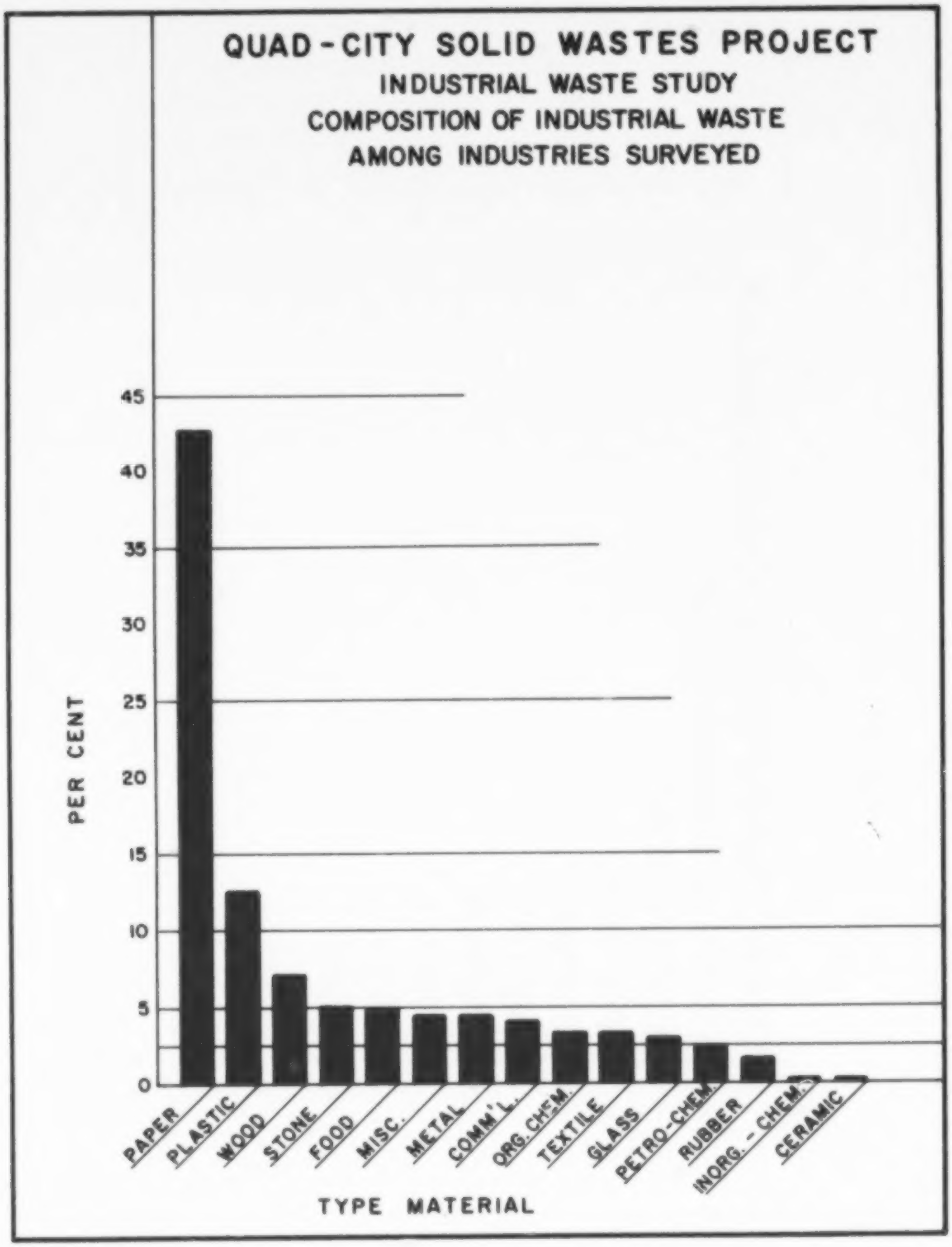

QUAD-CITY SOLID WASTES PROJECT
INDUSTRIAL WASTE STUDY
COMPOSITION OF INDUSTRIAL WASTE
AMONG INDUSTRIES SURVEYED
PER CENT
45
40
35
30
25
20
15
10
5
0
PAPER
PLASTIC
WOOD
STONE
FOOD
MISC.
METAL
COMM'L.
ORG. CHEM.
TEXTILE
GLASS
PETRO-CHEM.
RUBBER
INORG.-CHEM.
CERAMIC
TYPE MATERIAL

Figure 2-15

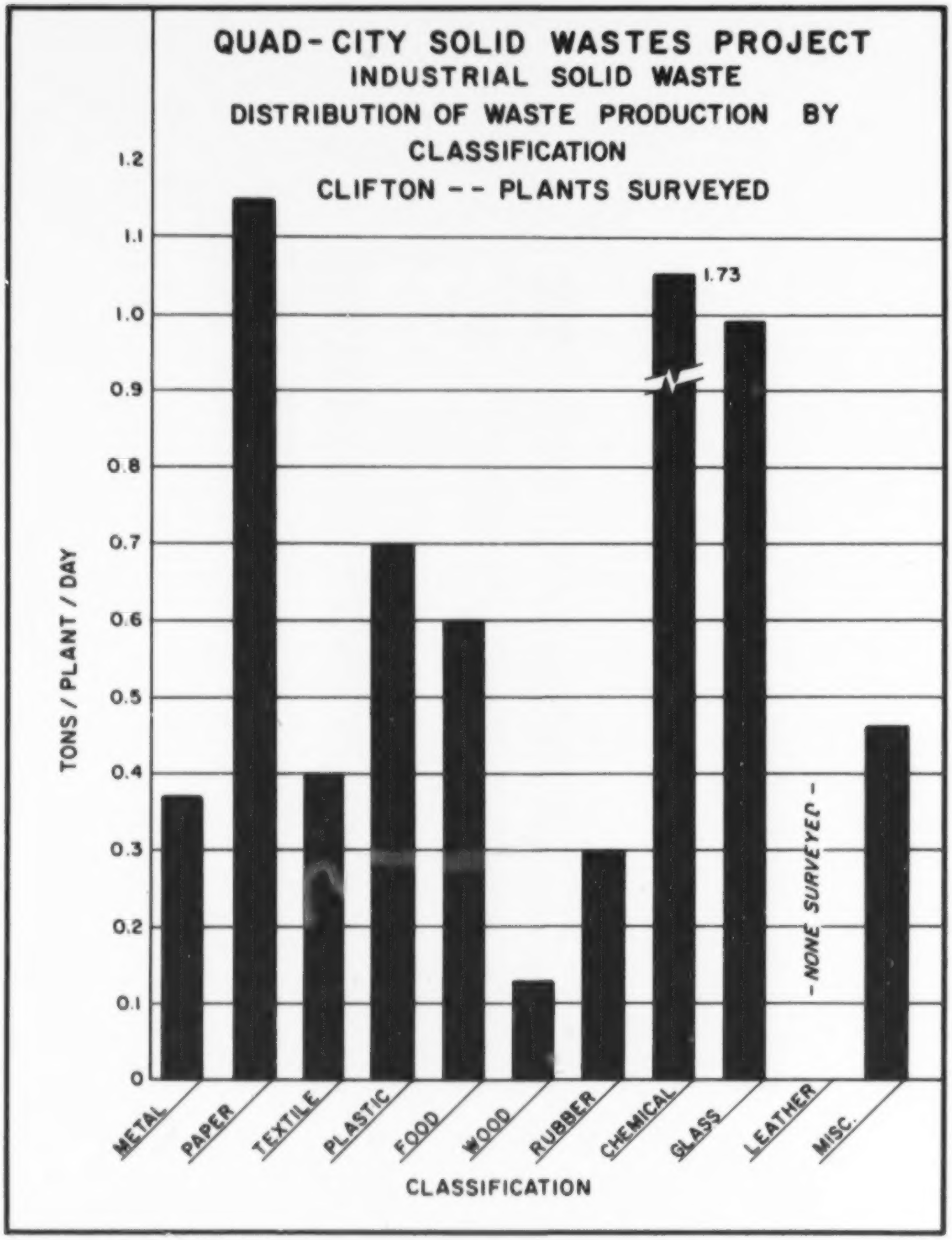


Figure 2-16

77

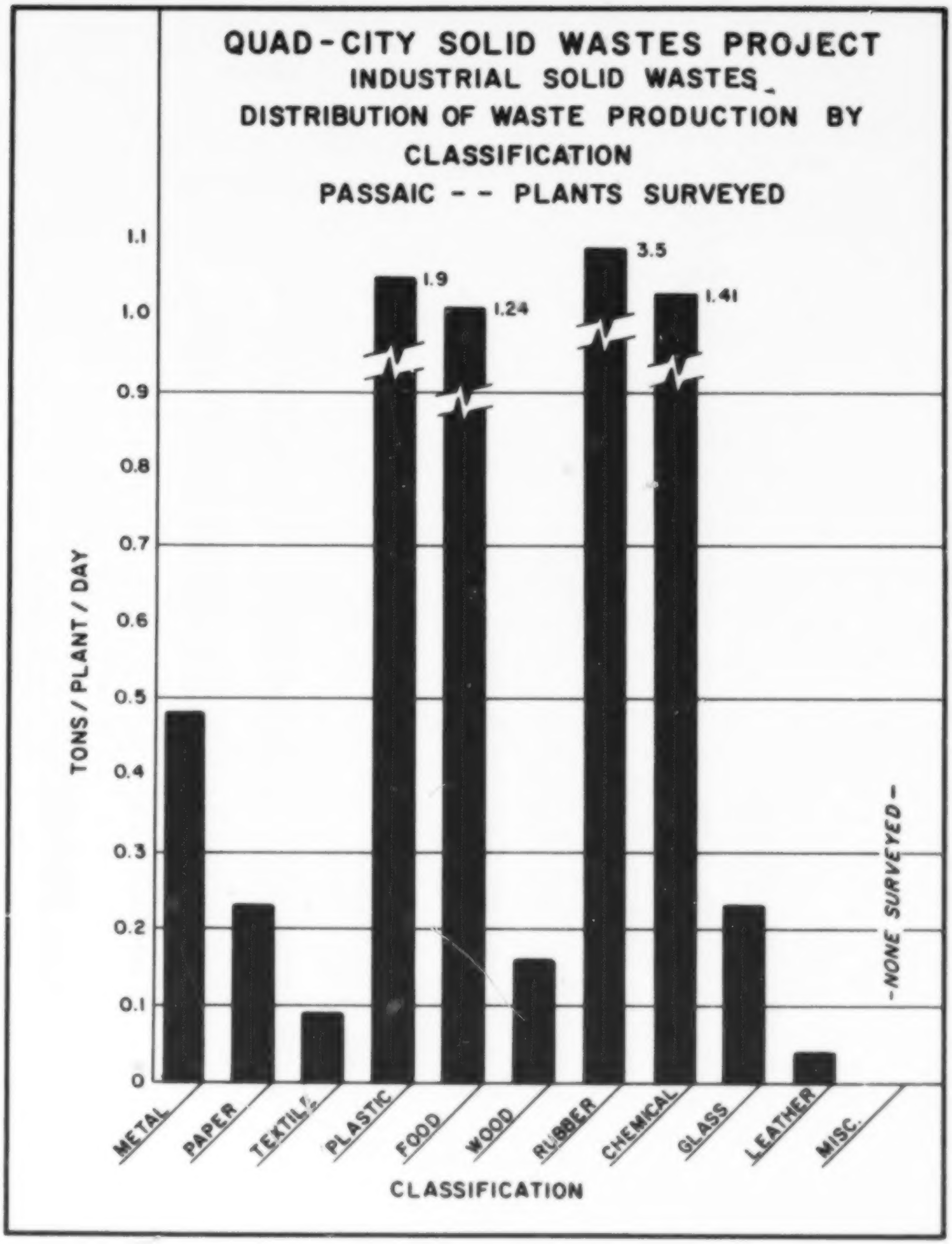

QUAD-CITY SOLID WASTES PROJECT
INDUSTRIAL SOLID WASTES
DISTRIBUTION OF WASTE PRODUCTION BY CLASSIFICATION
PASSAIC -- PLANTS SURVEYED
TONS / PLANT / DAY
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1.9
1.24
3.5
1.41
-NONE SURVEYED-
METAL
PAPER
TEXTILE
PLASTIC
FOOD
WOOD
RUBBER
CHEMICAL
GLASS
LEATHER
MISC.
CLASSIFICATION

Figure 2-17

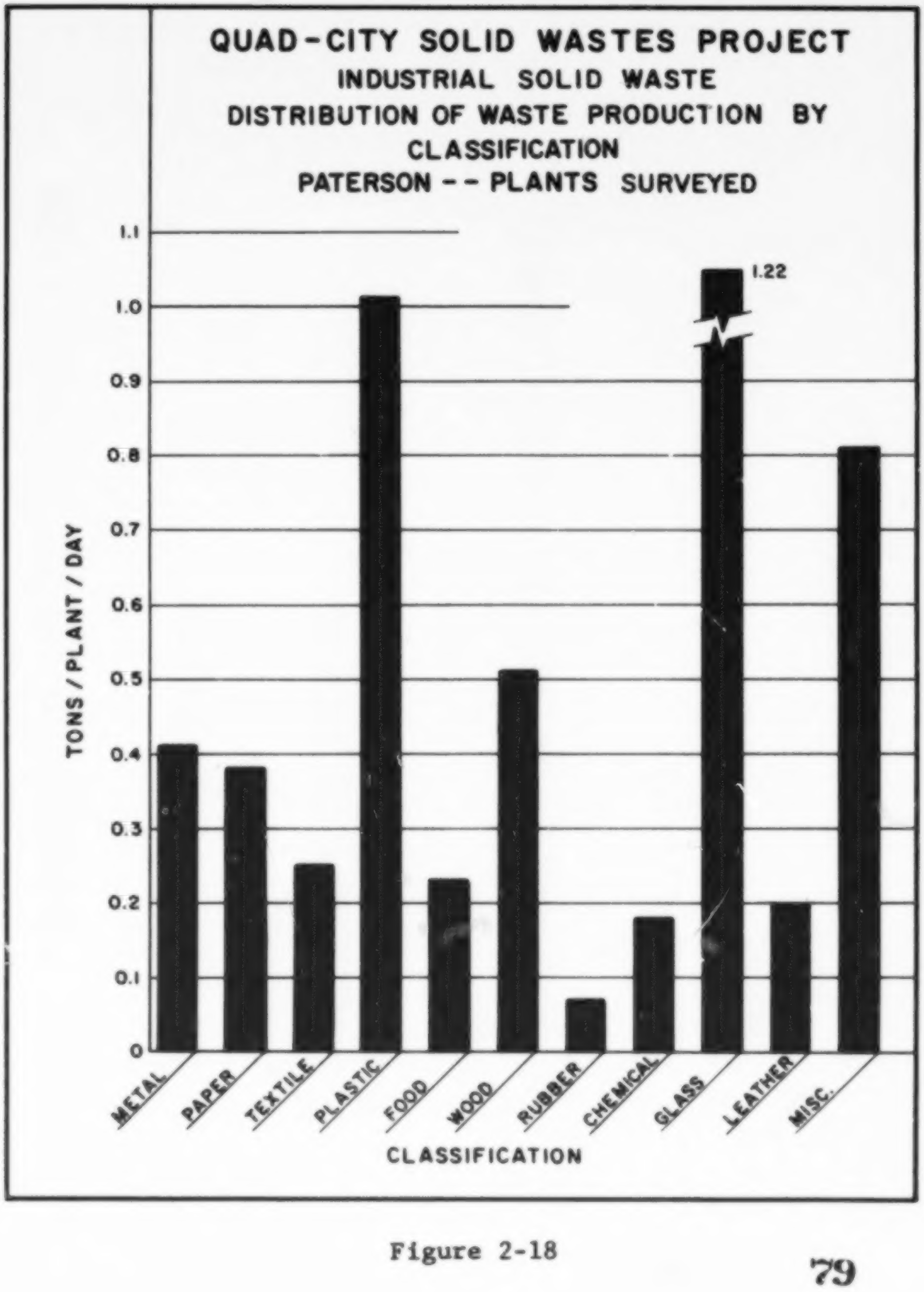

QUAD-CITY SOLID WASTES PROJECT
INDUSTRIAL SOLID WASTE
DISTRIBUTION OF WASTE PRODUCTION BY CLASSIFICATION
PATERSON -- PLANTS SURVEYED
TONS / PLANT / DAY
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.22
METAL
PAPER
TEXTILE
PLASTIC
FOOD
WOOD
RUBBER
CHEMICAL
GLASS
LEATHER
MISC.
CLASSIFICATION

Figure 2-18

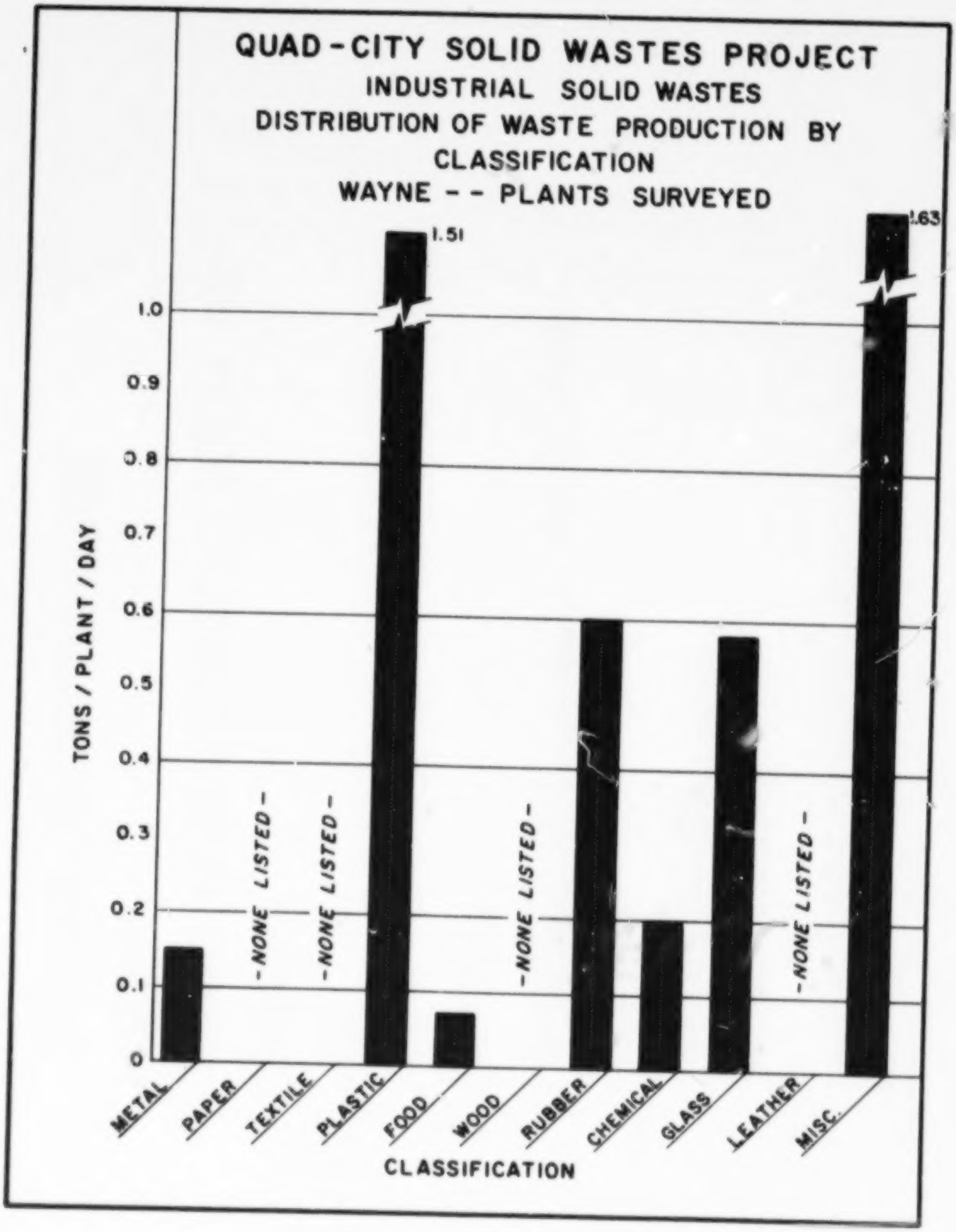

QUAD-CITY SOLID WASTES PROJECT
INDUSTRIAL SOLID WASTES
DISTRIBUTION OF WASTE PRODUCTION BY CLASSIFICATION
WAYNE -- PLANTS SURVEYED
TONS / PLANT / DAY
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.51
1.63
-NONE LISTED-
-NONE LISTED-
-NONE LISTED-
-NONE LISTED-
METAL
PAPER
TEXTILE
PLASTIC
FOOD
WOOD
RUBBER
CHEMICAL
GLASS
LEATHER
MISC.
CLASSIFICATION

Figure 2-19

Table 2-10

Quad-City Solid Wastes Project

Industrial Inventory
Solid Waste Production
Four Communities

Category	No. Plants in Category	No. Plants Surveyed	% Surveyed	Total Wastes #/week	Estimated Waste #/plant/week
Metals	308	99	32	540,069	5,455
Paper	76	24	32	272,905	11,371
Textiles	376	80	21	236,346	2,954
Plastics	49	22	45	377,011	17,137
Food	32	13	41	77,040	5,926
Wood	30	11	37	53,469	4,861
Rubber	14	7	50	120,229	17,175
Chemicals	74	28	38	418,406	14,943
Glass	35	18	51	198,803	11,045
Leather	10	2	20	3,427	1,714
Misc.	39	17	44	232,701	13,688

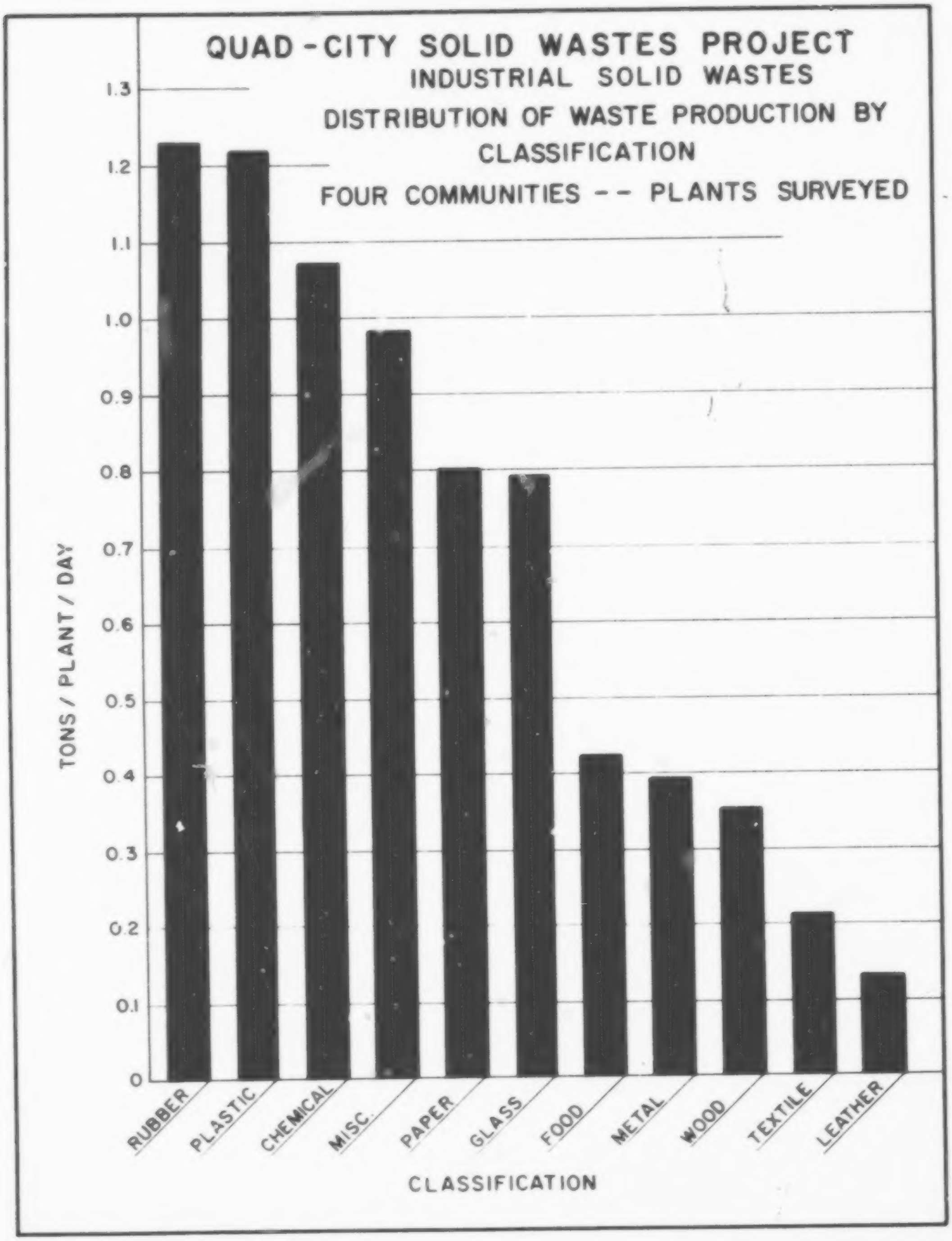

QUAD-CITY SOLID WASTES PROJECT
INDUSTRIAL SOLID WASTES
DISTRIBUTION OF WASTE PRODUCTION BY CLASSIFICATION
FOUR COMMUNITIES -- PLANTS SURVEYED
TONS / PLANT / DAY
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
RUBBER
PLASTIC
CHEMICAL
MISC.
PAPER
GLASS
FOOD
METAL
WOOD
TEXTILE
LEATHER
CLASSIFICATION

Figure 2-20

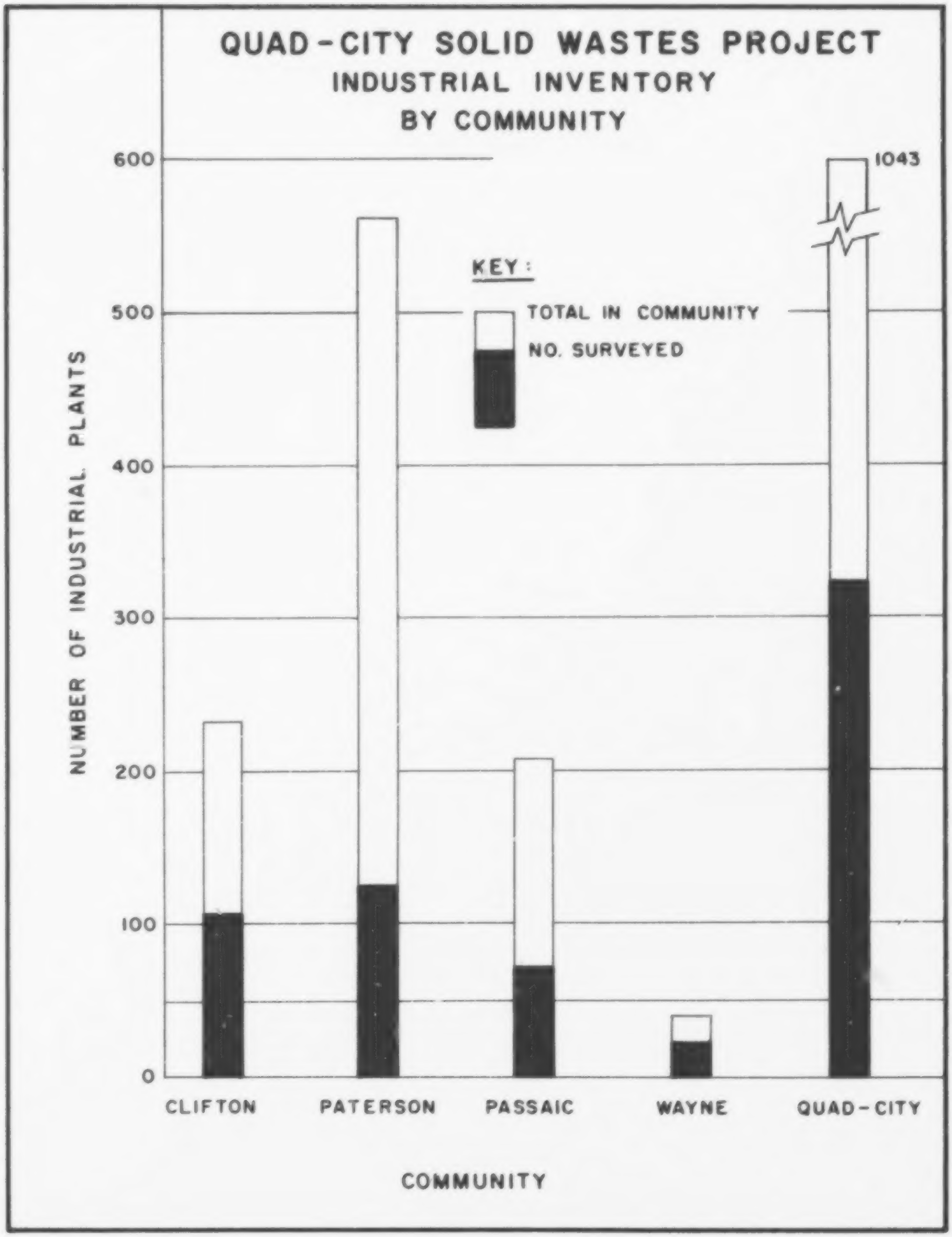

QUAD-CITY SOLID WASTES PROJECT
INDUSTRIAL INVENTORY
BY COMMUNITY
KEY:
TOTAL IN COMMUNITY
NO. SURVEYED
NUMBER OF INDUSTRIAL PLANTS
600
500
400
300
200
100
0
1043
CLIFTON
PATERSON
PASSAIC
WAYNE
QUAD-CITY
COMMUNITY

Figure 2-21

Table 2-11

Quad-City Solid Wastes Project

Industrial Waste Production
by
Community
in #/capita/day*

Industrial Category	Clifton	Paterson	Passaic	Wayne	Quad-City
Metal	.84	.80	.90	.14	.78
Paper	.70	.24	.10	--	.41
Textile	.27	.75	.35	--	.52
Plastic	.30	.35	.58	.52	.38
Food	.17	.09	.12	--	.10
Wood	.03	.11	.05	--	.05
Rubber	.03	.005	.52	.04	.10
Chemical	1.05	.09	.39	.05	.50
Glass	.22	.30	.05	.04	.17
Leather	--	.02	.002	--	.05
Misc.	.17	.14	--	.80	.25
Totals	3.780	2.895	3.062	1.59	3.31

*All figures based on 7-day week.

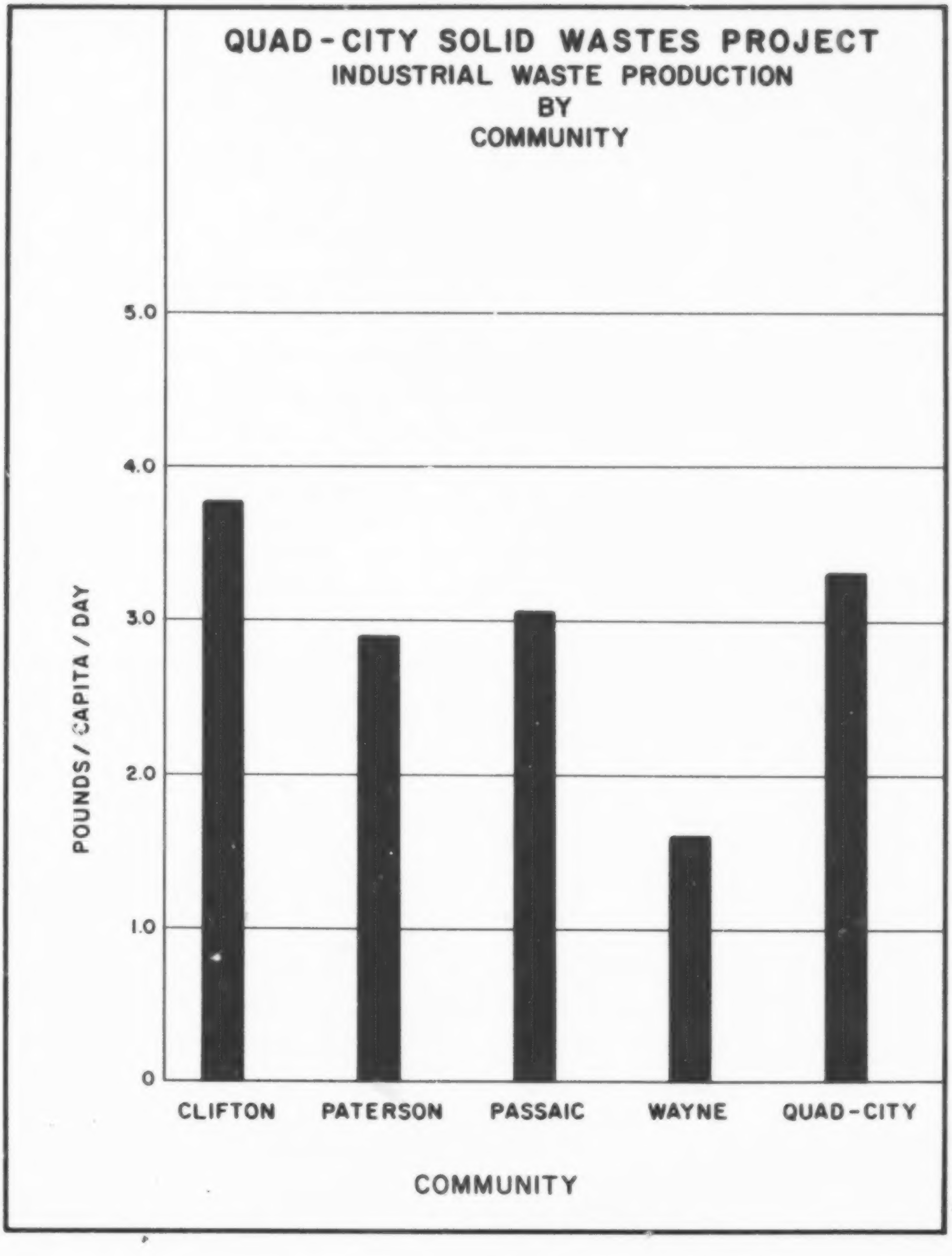

QUAD-CITY SOLID WASTES PROJECT
INDUSTRIAL WASTE PRODUCTION
BY
COMMUNITY
POUNDS / CAPITA / DAY
5.0
4.0
3.0
2.0
1.0
0
CLIFTON
PATERSON
PASSAIC
WAYNE
QUAD-CITY
COMMUNITY

Figure 2-22

The total per capita industrial waste production for an individual community was determined by summing up per capita production in each classification in that community according to Equation 2-1. For one community the equation is:

$$\frac{w_C}{n} \times \frac{i_{TC}}{i_{SC}} = w_T \qquad (2\text{-}1)$$

where:

w_C = waste production in classification for 7-day week in lbs/day.

n = population of city.

i_{TC} = total industries in classification.

i_{SC} = industries surveyed in classification.

w_T = waste production for all industry in community in lbs/capita/day.

The procedure followed for each community was used for the Quad-City region as a community unit. In this case, production and number of industries in each community by classification were totalled to represent the Quad-City unit. The population used was the sum population of the four communities.

Thus for Quad-City:

$$\frac{W_C}{N} \times \frac{I_{TC}}{I_{SC}} = W_T \qquad (2\text{-}2)$$

where:

W_C = total waste production in classification for 7-day week in #/day.

N = total population of Quad-City communities.

I_{TC} = total industries in classification.

I_{SC} = total industries surveyed in classification.

W_T = total waste production for all industry in Quad-City in #/capita/day.

The number of industries surveyed for the Quad-City unit was 324 of 1,043 listed or 31%. The percentage surveyed in any category ranged from 21% in the textile category to 51% in the glass category. The quantity of industrial waste disposed of in landfills varied from 1,361 lbs/day (Passaic County) to 305,327 lbs/day (Bergen County).

The projected total daily per capita industrial waste production was computed to be for Clifton (3.78), Paterson (2.89), Passaic (3.06), and Wayne (1.59). The Quad-City as a unit was 3.31 #/capita/day. When the industrial per capita production for Wayne (1.59) is subtracted from Wayne's residential/commercial/industrial per capita figure obtained during the three assays (4.18), a residential/commercial figure of 2.59 #/capita/day is obtained. This result falls in line with residential/commercial data from the other communities and supports or reinforces the statistical procedure used for extrapolating the surveyed industrial waste into the total production of industrial waste.

The relative amounts of waste generated by each industrial category are shown in Figure 2-23 in descending order. The metal industry is the most productive with 0.78 #/capita/day and leather and wood the least with 0.05 #/capita/day.

Construction-Demolition Survey

The objective of Construction/Demolition survey was to identify the amount and characteristics of solid wastes generated in the Quad-City area related to construction and demolition activities. Data were obtained from primary sources, demolition and construction contractors, and from the observations of the staff of construction and demolition activities in the Quad-City area. In addition, calculations of weight were made of typical structures from one family frame dwellings to industrial buildings.

As part of this study, the staff also investigated construction/demolition disposal as it now exists in the Quad-City area. Certain observations were noted and documented. Based on this study, it is believed that the estimate of wastes generated, which includes industrial and commercial/residential,

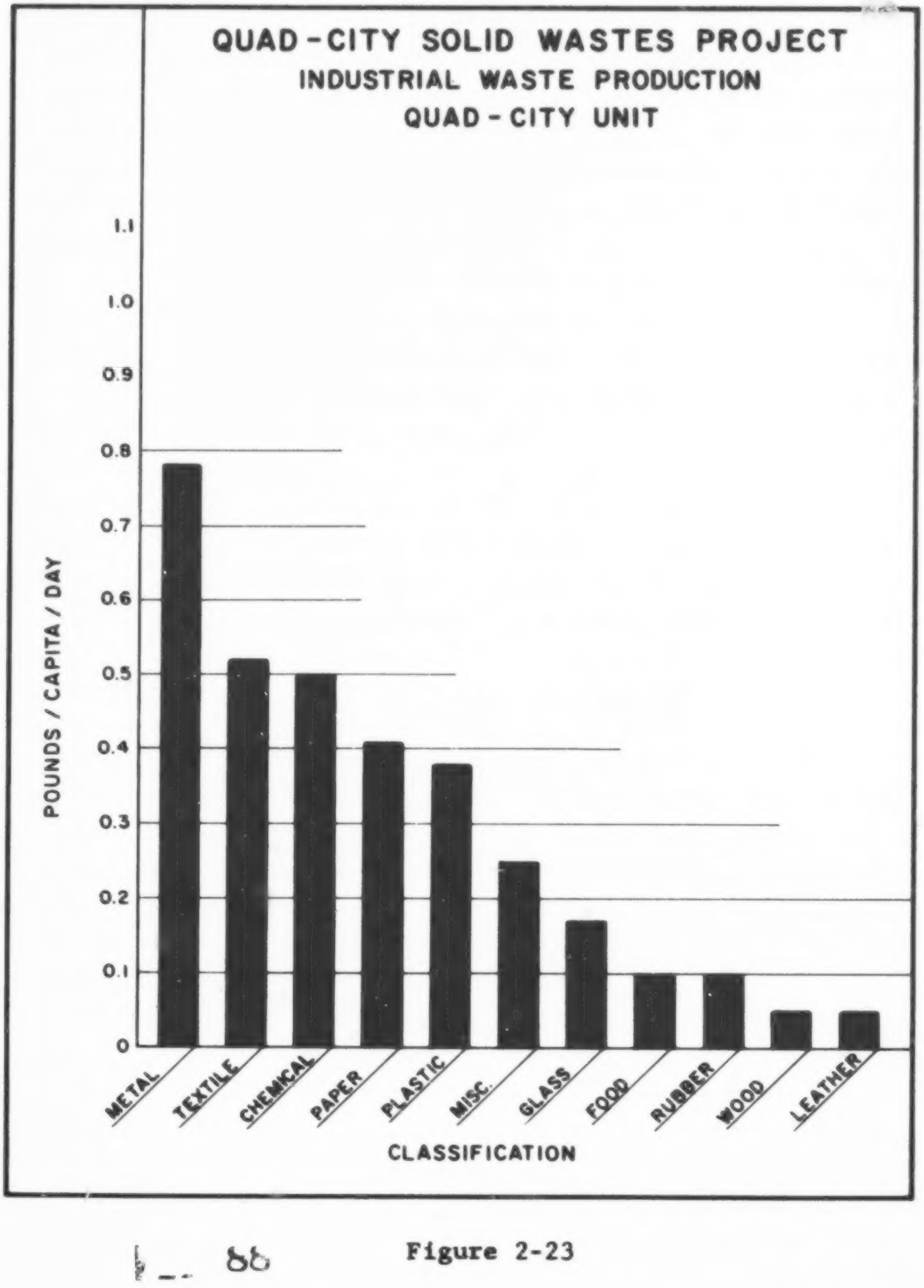


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Figure 2-23

construction/demolition wastes, is sufficiently reliable to be used as an input to an ultimate disposal system for the Quad-City area. The construction/demolition waste generated per year based on this survey is 116,690 tons, approximately 310 tons per day or 2.47 pcd.

The survey was divided into two phases of production: construction wastes and demolition wastes. Data were obtained from planning departments of the four municipalities with regard to construction in terms of dollars per year and demolition in terms of structures per year in each of six major categories. Demolition and construction contractors were interviewed to obtain specific information. In addition, calculations were performed to determine the weight percents of the major material of construction in each of the six building categories.

New Construction

Construction debris is disposed of in many ways. Combustibles, in many situations, are burned on the site in open fires or semi-enclosed fires, particularly during the cooler months. Construction combustible wastes are used during the winter months to provide a warm-up source for workmen and to heat up sand and water used in mortar mixes. Scavengers also pick-up scrap pieces of wood and other debris for personal use or resale. In cases where "no open burning" regulations are rigidly enforced, the combustible debris is hauled away to some form of disposal, usually a dumping area that may or may not be an organized and supervised landfill.

Non-metallic inert materials, such as brick, cinder blocks, spent mortar sand concrete, plaster tiles, etc., normally collect on site during construction and prior to paving and landscaping are buried on site if the site is sufficient to accommodate burial. On small sites, downtown areas, the non-metallic debris is hauled away to legal or illegal dumping sites.

Due to its characteristics, non-combustible debris is accepted at several locations in the Quad-City area as clean fill and is covered over with dirt at the fill sites. It was found that metallic debris can be considered 100% salvageable for the purposes of this study.

Table 2-12, showing yards of removed debris, was developed. Table 2-13 provides the dollars of construction in each of six categories. Utilizing approximate cost per square foot of floor space for each category, the dollars of construction per category and Table 2-12, yards of debris or tons removed for each of the six categories was calculated on a yearly basis. An extrapolation based on knowledge of planned construction has been carried to 1970.

Demolition

The procedure used to calculate the amount of demolition debris was quite similar to the procedure used for the construction wastes.

Table 2-14, showing the amount of wastes removed from the demolition of typical structures, was developed from observations and interviews with a demolition contractor. The amount varies from 15 to 70 cy per building.

Table 2-15 indicates the number of demolitions for each category in each community. The amount of demolition debris generated for each structure category is obtained by calculation. These data have been extrapolated for each community on an annual basis.

Calculated Weights of Typical Structures

In order to confirm data from primary sources, weights of typical structures were estimated. The construction of seven typical buildings as shown in Table 2-16 was analyzed from design drawings available. The weights of building materials in terms of pounds per square foot were obtained using standard references, including American Institute of Steel Construction Handbook and other architectural handbooks. The calculations are provided in Appendix A2-3. Table 2-16 provides the tabulated data.

Table 2-12

Quad-City Solid Wastes Project

New Construction
Waste Debris Production

Type of Structure	Debris Removed cu. yd.
1 Family Frame	15
1 Family Brick	15
2 Family Frame	20
2 Family Brick	20
6 Family Tenement Frame	30
6 Family Tenement Brick	30
1 story 100' x 200' Building	70

Table 2-13

Quad-City Solid Wastes Project

Building Construction
Thousands of Dollars
by
Year

	Paterson			Clifton			Passaic			Wayne (estimated)		
	1966	1968	1970	1966	1968	1970	1966	1968	1970	1966	1968	1970
Residential 1 & 2 Family Dwellings	299	150	150	1,631	1,700	1,800	120	60	150	1,700	1,700	1,700
Garden Apts.	200	200	200	60	70	100	700	400	500	3,000	3,000	3,000
Apartments	200	300	300	36	100	200	600	400	1,000	2,000	2,000	2,000
Total Residential	699	650	650	1,727	1,870	2,100	1,420	860	1,650	6,700	6,700	6,700
Commercial	230	400	400	574	600	700	50	200	400	4,000	4,000	4,000
Industrial	895	1,000	1,000	2,636	2,600	2,600	280	400	400	2,000	2,000	2,000
Government	3,653	3,000	3,000	--	--	600	--	200	200	--	500	500
Institutional	--	1,000	1,500	3,300	3,000	3,000	400	350	250	--	1,000	2,000
Other	--	--	--	43	50	50	--	--	--	--	--	--
Total All Construction	5,475	5,900	6,550	8,280	8,120	9,050	2,150	2,010	2,900	12,700	14,200	15,200

Table 2-14

Quad-City Solid Wastes Project

Demolition of Typical Structures
Amount of Wastes

Type of Structure	Cubic Yards	Tons
1 Family Frame (25 x 100 lot)	160	56
1 Family Brick (brick salvaged)	160	56
2 Family Frame	200	70
2 Family Brick (brick salvaged)	200	70
6 Family Tenement Frame	800	280
6 Family Tenement Brick (brick salvaged)	800	280
100' x 200' commercial or factory structure (1 story brick, light bay, wood trusses, wood roof, concrete floor, miscellaneous pipings, electrical, etc.)	4,200	1,470
1-3 story hotel, apartment, commercial complex (approximately 100' x 100' extensive brick, metal stone salvaging)	4,000	1,400

Table 2-15

Quad-City Solid Wastes Project

Number of Demolitions
by
Year

	Paterson			Clifton			Passaic			Wayne (estimated)		
	1966	1968	1970	1966	1968	1970	1966	1968	1970	1966	1968	1970
Residential 1 & 2 Family Dwellings	47	60	20	54	13	35	6	10	10	5	10	30
Garden Apts.	0	0	0	0	0	0	0	0	0	0	0	0
Apartments & Tenements	4	10	10	0	4 (32 units)	4	4	6	7	0	0	0
Total Residential	51	70	30	54	17	39	10	16	17	5	10	30
Commercial	26	4	4	3	7	7	0	5	10	0	0	0
Industrial	2	1	1	0	3	2	1	1	1	0	0	0
Institutional	1	1	1	0	0	0	0	0	0	0	0	0
Other	2	0	0	0	0	0	1	1	1	0	0	0
Total Annual Demolitions	82	76	36	57	27	48	12	23	29	5	10	30

Table 2-16

Quad-City Solid Wastes Project

Summary of Calculated Weights of Typical Structures in the Quad-City Area Subject to Demolition

Type of Structure	Weight (tons)
1 Family Frame 55' x 22'	171.8
1 Family Brick 55' x 22'	207.4
2 Family Frame 55' x 22' 2 stories	213.2
2 Family Brick 55' x 22' 2 stories	274.5
6 Family Frame 55' x 22' 3 stories	428.9
6 Family Brick 55' x 22' 3 stories	709.9
Industrial Bldg. 100' x 200'	1396.9

Notes: 1) All residential buildings with basement.
2) No salvaging or burial on-site involved.

The calculated weight of typical structures exceeds weight of the debris removed. Estimates given in Table 2-14 allow for salvaging and on-site burial. Weights range from 172 T to 1400 T per structure.

The percent combustibles for the seven typical structures based on the calculated weight is shown in Table 2-17 and in Appendix A2-4. The combustibles are represented as 95% wood and 5% other combustibles, which could be paper, felt, some roofing and insulation materials and combustible decorative finishes.

Table 2-18 provides an estimate of the amount of demolition debris disposed of in the Quad-City area and Table 2-19 is an estimate of the debris from new construction that is disposed of. Table 2-20 is the total weight of both construction and demolition wastes for 1966 and estimated for 1968 and 1970. It has been estimated that construction/demolition debris disposed of in the Quad-City area amounted to about 102,060 tons in 1966. This is approximately 87.5% of the estimated construction/demolition debris generated.

As mentioned earlier, solid wastes generated from construction and demolition activities are ultimately disposed of at sanitary landfills in Bergen County, in Passaic County, or at unauthorized "clean" fill sites in the Quad-City area. Salvageable materials such as brick, structural steel, stone work, etc., are recovered and sold. In some cases debris is buried or burned on site. Appendix A2-5 shows a typical interview with a demolition contractor and provides additional background on the disposal of construction/demolition wastes.

Clean-Up Week Survey

Clean-up week was started several years ago with the idea that citizens would have an opportunity to clean out their basements, attics, garages and yards in order to prevent fires and to improve the general appearance of their properties. It involves picking up, by municipal contractor or Department of Public Works personnel, items which would not normally be picked up

Table 2-17

Quad-City Solid Wastes Project

Percent Combustibles Based on Calculated Weights

Type of Structure		Percent Combustibles by Weight
1 Family Frame	55' x 22' (1 story)	13.0
1 Family Brick	55' x 22' (1 story)	9.0
2 Family Frame	55' x 22' (2 stories)	12.0
2 Family Brick	55' x 22' (2 stories)	8.5
6 Family Frame	55' x 22' (3 stories)	11.5
6 Family Frame	55' x 22' (3 stories)	8.0
Industrial Bldg.	100' x 200' (1 story)	5.0

Table 2-18

Quad-City Solid Wastes Project

Demolition Debris--Quad-City Communities
by
Year

	Tons		
	1966	1968	1970
Paterson	54,600	57,190	34,400
Clifton	12,200	19,700	25,600
Passaic	11,200	27,200	32,200
Wayne	1,000	10,000	30,000
Total	79,000	114,090	122,200

Table 2-19

Quad-City Solid Wastes Project

Construction Debris--Quad-City Area

	Tons		
	1966	1968	1970
Paterson	5,025	5,265	5,300
Clifton	8,310	8,870	9,830
Passaic	1,480	2,040	2,820
Wayne	8,250	8,400	8,800
Total	23,465	24,575	26,750

Table 2-20

Quad-City Solid Wastes Project

Total Construction/Demolition Debris

	Tons		
	1966	1968	1970
Paterson	59,620	62,450	39,700
Clifton	20,510	28,570	35,430
Passaic	12,680	29,640	35,020
Wayne	9,250	18,400	38,800
Total	102,060	129,060	118,950

during regular refuse collection. These items normally fall into the oversized objects category, i.e., washers, television sets, refrigerators, stoves, furniture, etc. Clean-up weeks are conducted during the spring and fall, normally for a period of one week in each season.

Clean-up is conducted by the municipal contractors in Paterson, Passaic and Wayne. The Department of Public Works handles the entire clean-up for Clifton and the Paterson Department of Public Works assists the city contractor.

The collectors were asked to keep an inventory of the number of loads collected, volume, weight, type of items collected, and length of clean-up. A density of 400 #/cy was used when values were reported in cubic yards. This figure, 400 #/cy, is a density obtained from a previous solid waste study done for the City of Montclair, New Jersey.

Information regarding fall clean-up was obtained from the responsible Public Works official in each community. Thus, it was reported that Paterson has approximately the same amount of material and Wayne estimated 10% higher than spring clean-up. Passaic and Clifton do not have fall clean-up. On the basis of this information daily per capita production figures for the yearly clean-up were obtained as shown in Table 2-21.

Spring clean-up ranged from six days in Paterson to 28 days in Passaic. The amount of material collected in the spring clean-up ranged from 1100 tons in Passaic to 4234 tons in Clifton. The totals for Quad-City were 11,331 tons in spring and 6,312 tons in the fall making an annual total of 17,643 tons or 0.31 #/capita/day production.

Street Sweepings

Street sweepings are performed by the Department of Public Works in each of the four communities. Mechanical street sweepers are sent out, depending on weather conditions, according to a prearranged schedule.

The amount of street sweepings and catch basin cleanings

Table 2-21

Quad-City Solid Wastes Project

Clean-Up Week Data

Item	Units	Paterson	Clifton	Passaic	Wayne	Quad-City
Length of Clean-Up:						
Spring	days	6	14	28	9	--
Fall	"	6	--	--	9	--
Total	"	12	14	28	18	--
Waste Production:						
Spring	tons	2,850	4,234	1,100	3,147	11,331
Fall	"	2,850	--	--	3,462	6,312
Total	"	5,700	4,234	1,100	6,609	17,643
Per Capita Production:	#/cap/day	0.22	0.28	0.11	1.23	0.31

in the Quad-City area was determined by questionnaire and follow-up interview with city Public Works Superintendents.

The total amount of material collected in the Quad-City unit was reported to be 86 tons per day with sewer and catch basin cleanings being 23% of the total, or approximately 20 tons per day. Clifton and Passaic disposed of this material by hauling to Bergen County landfills. Paterson disposes to Troy Hills in Morris County, and Wayne utilizes lowland fills in Wayne.

The percentage of street sweepings was estimated by public works officials to be 27% combustible.

The annual contribution of sweepings has been estimated for Quad-City to be 0.56 #/capita/day.

Junked Auto Survey

A junked auto survey was made to determine the number of these vehicles processed in the Quad-City area on a yearly basis. The survey was conducted via written questionnaire and follow-up visits.

It is difficult to identify the sources of the junked car, but based on discussions with the two major processors in the area, they were quite confident that 70-80% of the vehicles they process come from lower Passaic County. Paterson and Clifton auto processors account for 72.5% of the total number of junked autos in the Quad-City area or 21,830 vehicles. Weights of vehicles processed were not available at the time of this survey.

Junked autos are stripped of salvageable items, i.e., batteries, tires, engines, fenders, bumpers, etc., before processing. The "skeleton" is then compacted into bales and sold to a metal processor.

As long as junked cars in Passaic County are salvaged, either wholly or in part, they are not, in actuality, solid waste requiring some further treatment and ultimate disposal.

Data on junked autos are presented in Table 2-22.

Table 2-22

Quad-City Solid Wastes Project

Junked Auto Survey

Community	Autos	Other Vehicles	Total	% from Passaic County
Paterson	5,305	275	5,580	70
Clifton	15,500	750	16,250	75
Passaic	--	--	--	--
Wayne	--	--	--	--
Quad-City	20,805	1,025	21,830	72.5

SECTION 3

METEOROLOGY

In general the entire Quad-City area is dominated by valley-slope circulations. In times of strong pressure gradients, local winds will be influenced by (1) down wash in the lee of the mountain ridges with strong geostrophic level crosswinds, and (2) preferred wind direction frequencies to coincide with the valley-slope orientation. During periods of weak pressure gradients, valley-slope circulations will develop and each location can exhibit its own microclimate.

In general, valley-slope winds are caused by differential heating of the terrain. During the day the air over a slope will be warmer than air at the same height over the valley. The rising of the warm air creates a well defined wind up the slope (anabatic winds) while the reverse is true at night--cooler air from the slope flows downward into the valley (kadabatic winds). This cross-valley-slope pattern is complicated by a circulation along the longitudinal axis generated by differential heating of the air between the valley and the plains into which it drains. During the day the air in the valley will generally become warmer, rise and air will flow in from the plain. During the night, this process will reverse itself and the air will flow down the valley out to the plain. Both systems described above are further complicated by the heating pattern created by the diurnal march of the sun--selective slope heating (east or west depending on time of day).

The valley wind and slope winds characteristically exhibit an intermittent pattern in which steady state conditions rarely persist for any length of time. This intermittency may be caused in part by cold air accumulating behind a line of trees or other barrier, natural or manmade, and moving only when the density of air exceeds some critical value. Other causes may be attributed to differences in roughness, slope or height of the two sides of the valley with interaction of slope winds and/or the possibility of conflicts between slope and valley winds due to diurnal favoritism in slope heating.

There is little question but that the dominant geographic feature in the Quad-City area is the series of ridge lines and mountain chains that tend to isolate the area from the coastal plains of the lower Hudson River and Atlantic Ocean. At all times these mountains tend to modify the existing geostrophic wind patterns particularly at valley floor levels. The wind fields will undergo deformations and channeling that might well alter the wind direction, wind speed and temperature at any given specific location. These same features that alter the overriding geostrophic wind patterns give rise, in times of weak pressure gradients, to important local winds. The Preakness Valley formed by the Preakness Mountains, Second Watchung and Packamack Mountains is, essentially, a closed valley. The area between the First Watchung (Garrett Mountain) and the Second Watchung is part of an open ended valley. Outflows occur only through the Great Notch area on the south end and through the wider notch between Garrett Mountain and the First Watchung on the north end. Each of these areas will exhibit microclimates and flow patterns characteristic of their configurations.

In addition to spot checks of the area, field observations were conducted in October, November and January. A mobile weather observation unit was employed on traverse routes of the area. This unit, mounted on a vehicle, is taken to a station location and wind speed, and direction are measured. The station is occupied for 15 minutes and appropriate readings taken. An attempt was made to establish a reference station at the Totowa Airport, however this installation was in poor repair and it was necessary in these early studies to use Teterboro Airport weather data. One of the major conclusions reached after the January studies was that a prime weather station was needed in the area since relationship between traverse points and Teterboro was not consistent or acceptable. The details of a field study made on 31 January 1967 serve to illustrate conditions found.

The route followed is traced out in Figure 3-1. The survey sites included:

Garrett #3
Pennington #4
Reinhart #13
Van Houten #16

These sites have all been used in earlier surveys. The following additional new sites were selected and used:

17. Lakeview Road (140' msl)--next to Cedar Lawn Cemetery near Market Street and Interstate 80 in Paterson.
18. New Street (185' msl)--near Grand Street in Paterson.
19. McBride-Dowling Shopping Center (125' msl)--near intersection of McBride Avenue and Browertown Road in West Paterson.
20. Lackawanna (195' msl)--near Union Avenue in Totowa.
21. Totowa-Wayne Airport (178' msl)--on Naachtpunkt Road in Totowa.

The general weather was clear and the winds were calm to light and variable. The smoke from the stacks of Bergen Station of the Public Service was observed to rise straight upward with a slight easterly drift then it moved sharply to the north and fanned out at high levels. As the Quad-City area was approached, high cirrus clouds were observed with contrails. High smoke layers were observed while the low levels were clear.

From Garrett #3, at first visit, the First Watchung and area to the north were distinct but a high haze layer was obvious. Various plumes in the valley were observed to rise high and move out in all different directions. Two plumes in particular were observed at the base of the east face of Garrett Mountain--one moving east while the other moved south.

By the time that McBride-Dowling #19 was reached at 1200, the sky had become overcast and the weather raw. At Reinhart #13 about 1400, Garrett was not visible--the valleys to the east and west were seemingly in a white-out. There was a distinct odor of burning garbage or wet paper. In the valley

QUAD-CITY SOLID WASTES PROJECT

Air Ventilation Study
Survey Route Number 3
January 31, 1967

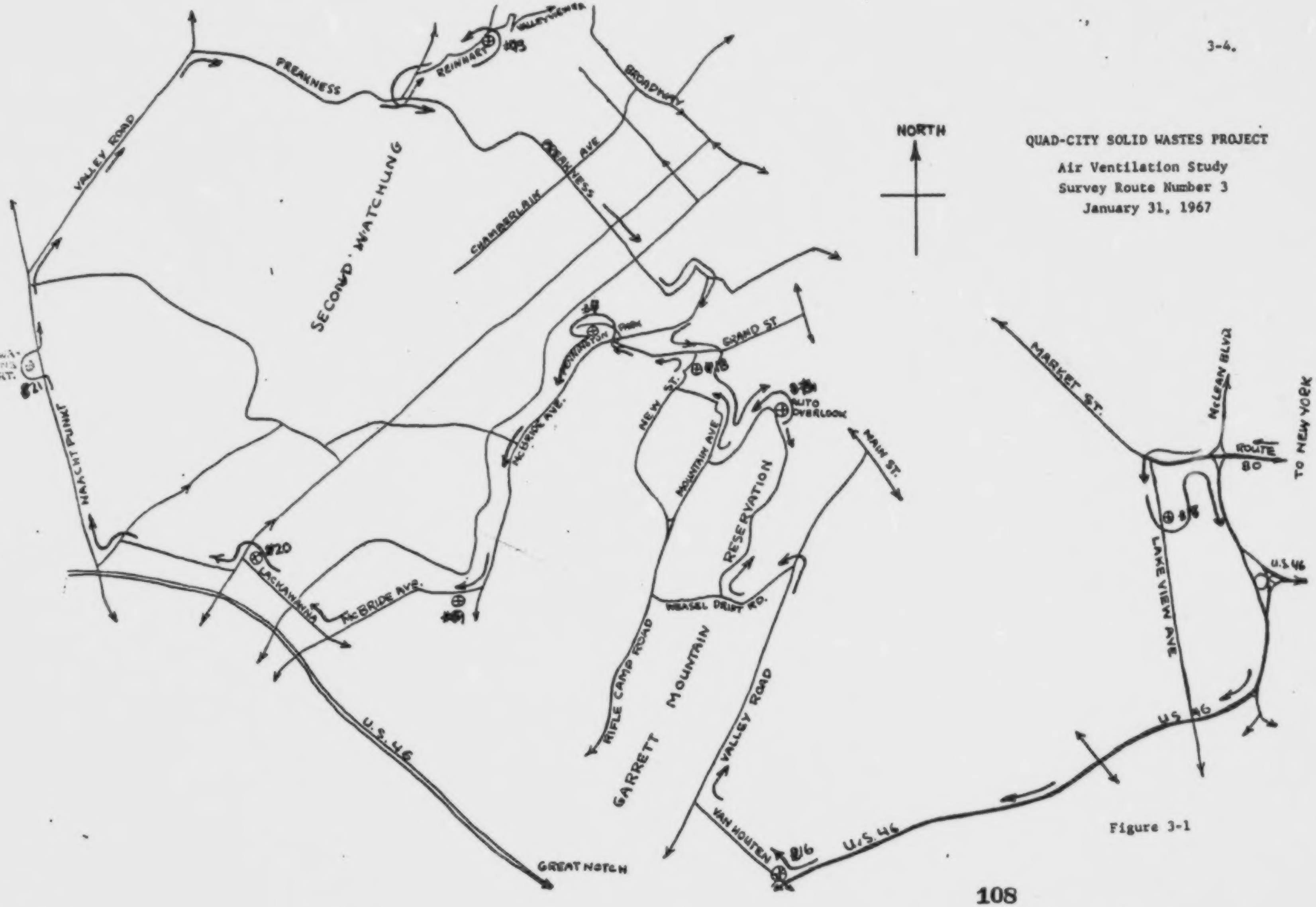


Figure 3-1

between Reinhart #13 and Garrett #3 the air was clear and the horizontal visibility good in all directions. At Garrett #3 from 1415 to 1430, there was eye-level haze in all quadrants. The First Watchung to the north was only vaguely visible; however, the visibility looking down into the valley was good. Once again, as on Reinhart #13, there was the distinct odor of burning garbage or wet paper.

Throughout this entire survey, the only available tie wind data came from hourly reports at Teterboro Airport. The anemometer system at the Totowa-Wayne Airport was inoperative. The results of this survey are presented in Table 3-1. It is observed that the winds measured at the various sites up to and including McBride-Dowling #19 were CALM or light easterlies. There was no change at #19 but at Lackawanna Road #20 the wind shifted to SSE but remained light. The wind was CALM at the T-W Airport #21 and light SSE at Reinhart #13. Fifteen minutes later at Garrett #3 the winds were from SSW-SW and increased in speed to 6-9 mph.

Examination of the wind reported at Teterboro Airport during the same time period of this survey indicated that a persistent shift to SW winds occurred between 1100 and 1200 and the speed increased between 1300 and 1400. There is no way to determine whether or not these changes correspond to those observed in the Quad-City area.

It was concluded at this time that while additional surveys could be made in the Quad-City area, their results will remain merely a collection of isolated readings from which no definitive conclusions could be drawn.

In an earlier field trip to the Quad-City area, November 23, 1966, a pattern of local weather was observed that differed sharply from that of January 31, 1967. The winds were generally light and from southerly quadrants. The entire area from New York westward was fog and smog-bound with valley floor visibility generally poor. From the vantage point of Garrett Mountain auto-overlook, it was observed that the entire area was

Table 3-1

Quad-City Solid Wastes Project

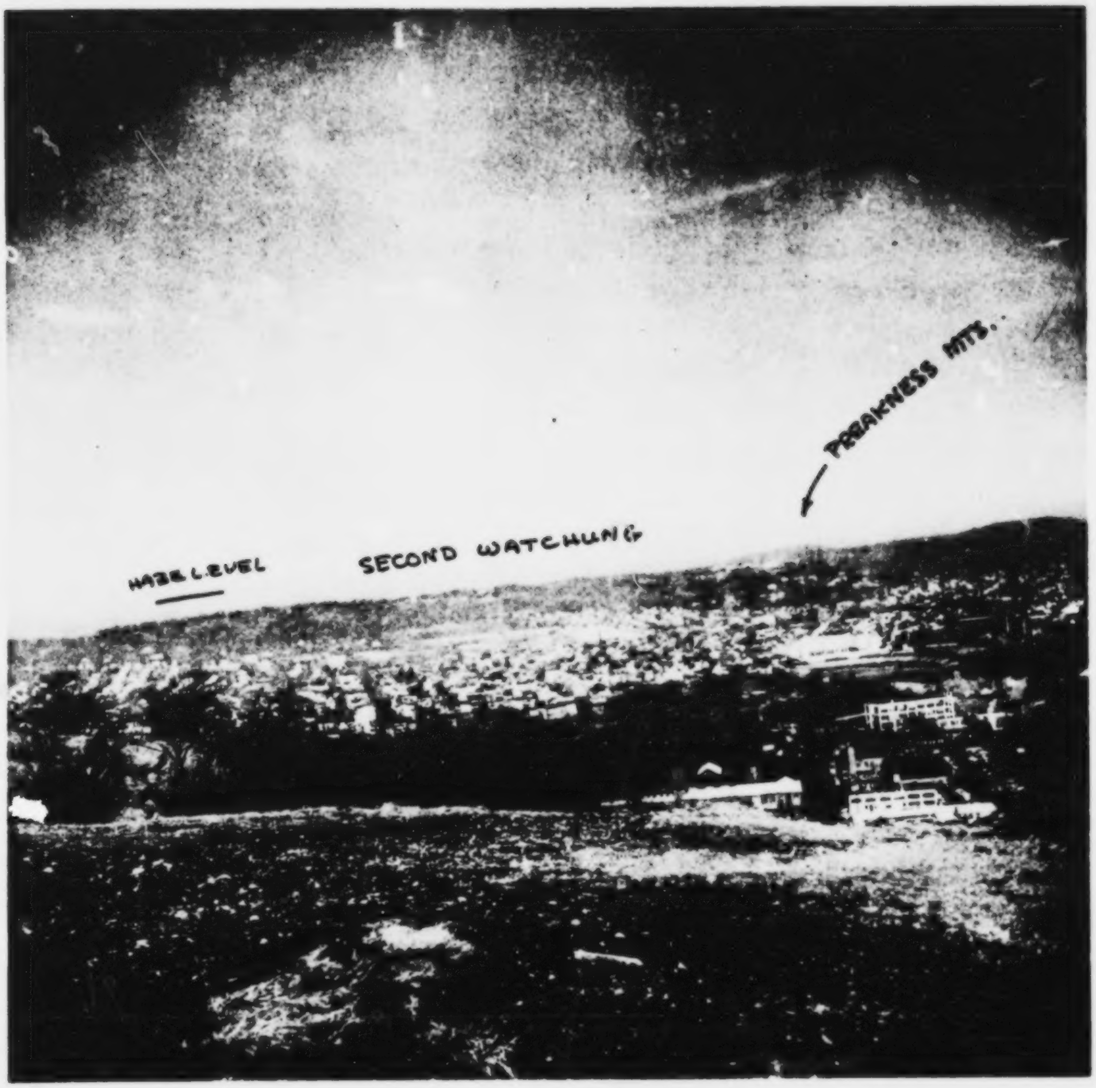
Results of Survey Number 3
January 31, 1967

Station	Time (EST) Start	Time (EST) End	Wind Velocity (1 min. aver.)	Extremes
Lakeview #17	1040	1045	Calm	WNW & 0-1 mph
	1045	1050	Calm	NE-SE & 0-1 mph
Van Houten #16	1100		No measurement-flag indicates Calm	
Garrett #3	1110	1115	E @ 1 mph	NE-SE & 0-4 mph
	1115	1120	E @ 3 mph	E-SE & 0-6 mph
New Street #18	1130	1135	E @ 3 mph	NE-SE & 2-6 mph
	1135	1140	ESE @ 2 mph	E-S & 1-4 mph
Pennington #4	1150	1155	Calm	SE-S & 0-1 mph
	1155	1200	Calm	SE-W & 0-1 mph
McBride-Dowling #19	1208	1213	E @ 1 mph	NNE-SE & 0-3 mph
	1213	1218	E @ 3 mph	E-SE & 0-6 mph
Lackawanna #20	1305	1310	SSE @ 3 mph	ESE-S & 0-6 mph
	1310	1315	SE @ 1 mph	SE-SSW & 0-2 mph
T-W Airport #21	1328	1333	Calm	Calm
	1333	1338	Calm	SSW-W & 0-2 mph
Reinhart #13	1350	1355	SSE @ 1 mph	SSE-SW & 0-6 mph
	1355	1400	SE @ 2 mph	SE-SSE & 0-4 mph
Garrett #3	1417	1422	SW @ 6 mph	SSE-SW & 4-9 mph
	1422	1427	SSW @ 5 mph	S-SW & 3-8 mph

Teterboro Airport		
	1000	320 @ 06 kts
	1100	160 @ 05 kts
	1200	210 @ 04 kts
	1300	230 @ 05 kts
	1400	210 @ 08 kts
	1500	210 @ 10 kts

inversion capped and smog filled. The only areas not visibly immersed were the ridge line of the Second Watchung Mountains to the west and Garrett Mountain itself. The First Watchung Mountains to the north were totally engulfed. The situation as it was seen is illustrated in photographs taken at the time of observation. Figure 3-2 looks northwest toward Second Watchung Ridge. Figure 3-3 looks north toward North Haledon. Figure 3-4 looks NNE at the First Watchung. Figure 3-5 is the same scene except on a clear day. Figure 3-6 looks ESE over Paterson and Figure 3-7 is the same except on a clear day. The variability of wind direction at the valley floor is illustrated in Figures 3-3 and 3-4 where various plumes are observed drifting off in different directions simultaneously; this is particularly obvious in Figure 3-4. Although it was not known at the time, the November 23 field trip had been made at the very onset of the Thanksgiving Day air pollution incident officially called the next day by the Public Health Service. The situation had been caused by a stagnant high pressure system and a low level subsidence inversion throughout the area.

It is apparent from both situations herein described (November 23, 1966 and January 31, 1967), neither of which can be considered uncommon occurrences, that any stack emissions proposed which would emanate from the vicinity of the valley floor must be subjected to severe review from the standpoint of air cleaning.



QUAD-CITY SOLID WASTES PROJECT

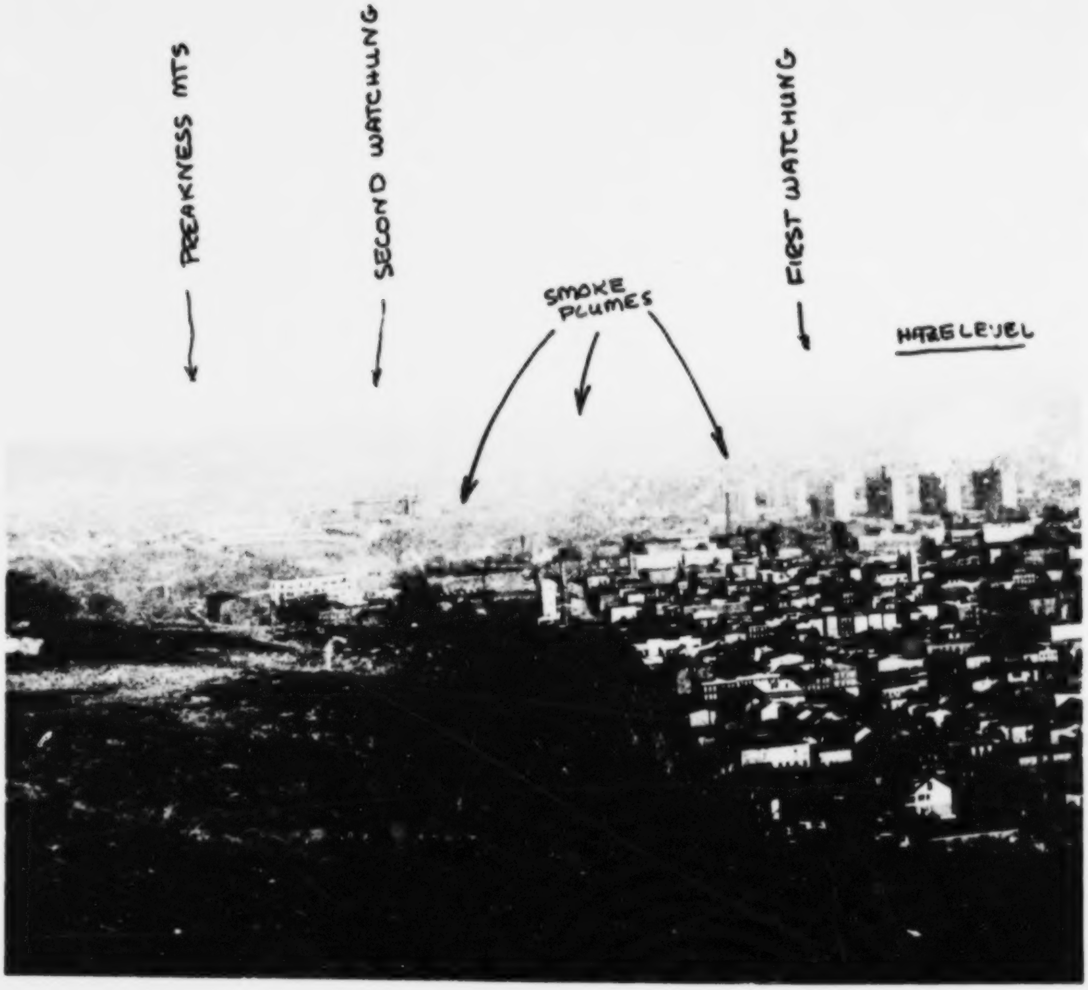
November 23, 1966 1000 EST

View from Garrett Mountain Reservation-Auto Overlook, elev. approx. 452' above M.S.L., looking NW.

Wind velocity at Teterboro Airport: 070 @ 4 kts.

Wind in local vicinity: Variable to SW @ 0-4 mph.

Figure 3-2



QUAD-CITY SOLID WASTES PROJECT

November 23, 1966 1000 EST

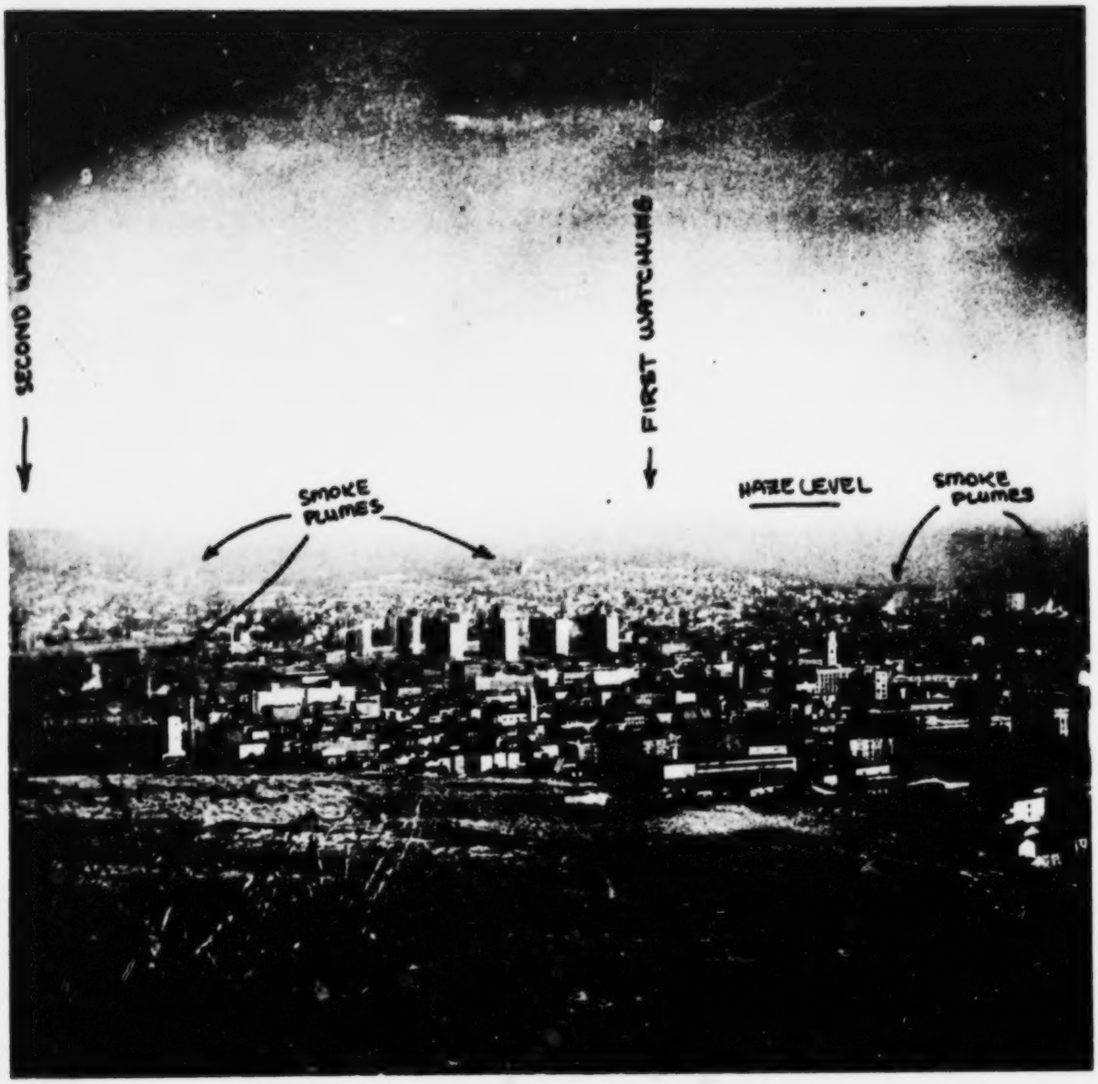
View from Garrett Mountain Reservation-Auto Overlook, elev. approx. 452' above M.S.L., looking N.

Plumes in foreground drifting with terrain orientation while those in background drifting off at apparent right angles.

Wind velocity at Teterboro Airport: 070 @ 4 kts.

Wind in local vicinity: Variable to SW @ 0-4 mph.

Figure 3-3



QUAD-CITY SOLID WASTES PROJECT

November 23, 1966 1000 EST

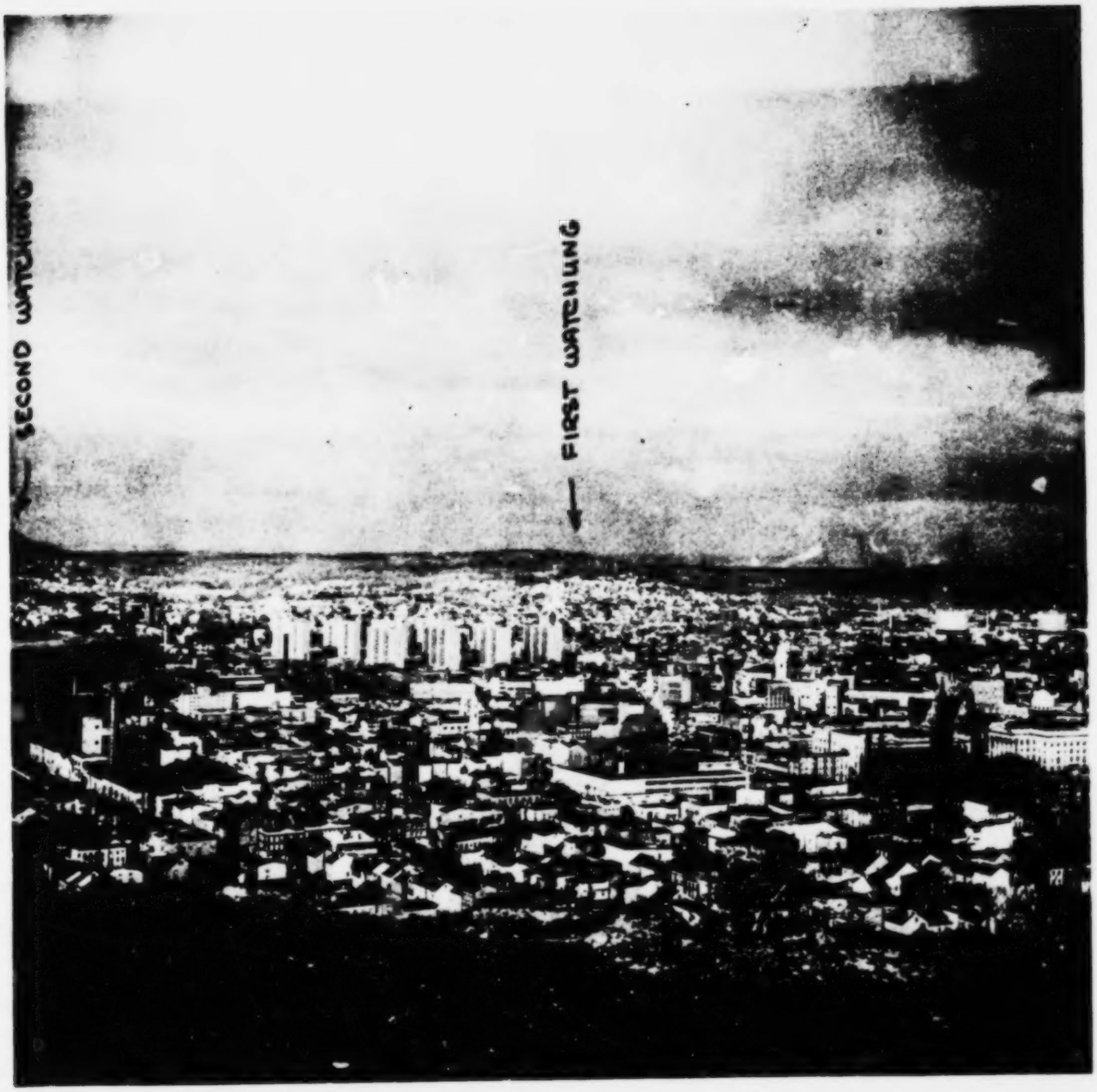
View from Garrett Mountain Reservation-Auto Overlook, elev. approx. 452' above M.S.L., looking N-NNE.

Various smoke plumes observed drifting in no preferential direction.

Wind velocity at Teterboro Airport: 070 @ 4 kts.

Wind in local vicinity: Variable to SW @ 0-4 mph.

Figure 3-4



QUAD-CITY SOLID WASTES PROJECT

November 30, 1966 1300 EST

View from Garrett Mountain Reservation-Auto Overlook, elev. approx. 452' above M.S.L., looking N-NNE.

Wind velocity at Teterboro Airport: 260 @ 15 kts.

Figure 3-5

QUAD-CITY SOLID WASTES PROJECT

November 23, 1966 1000 EST

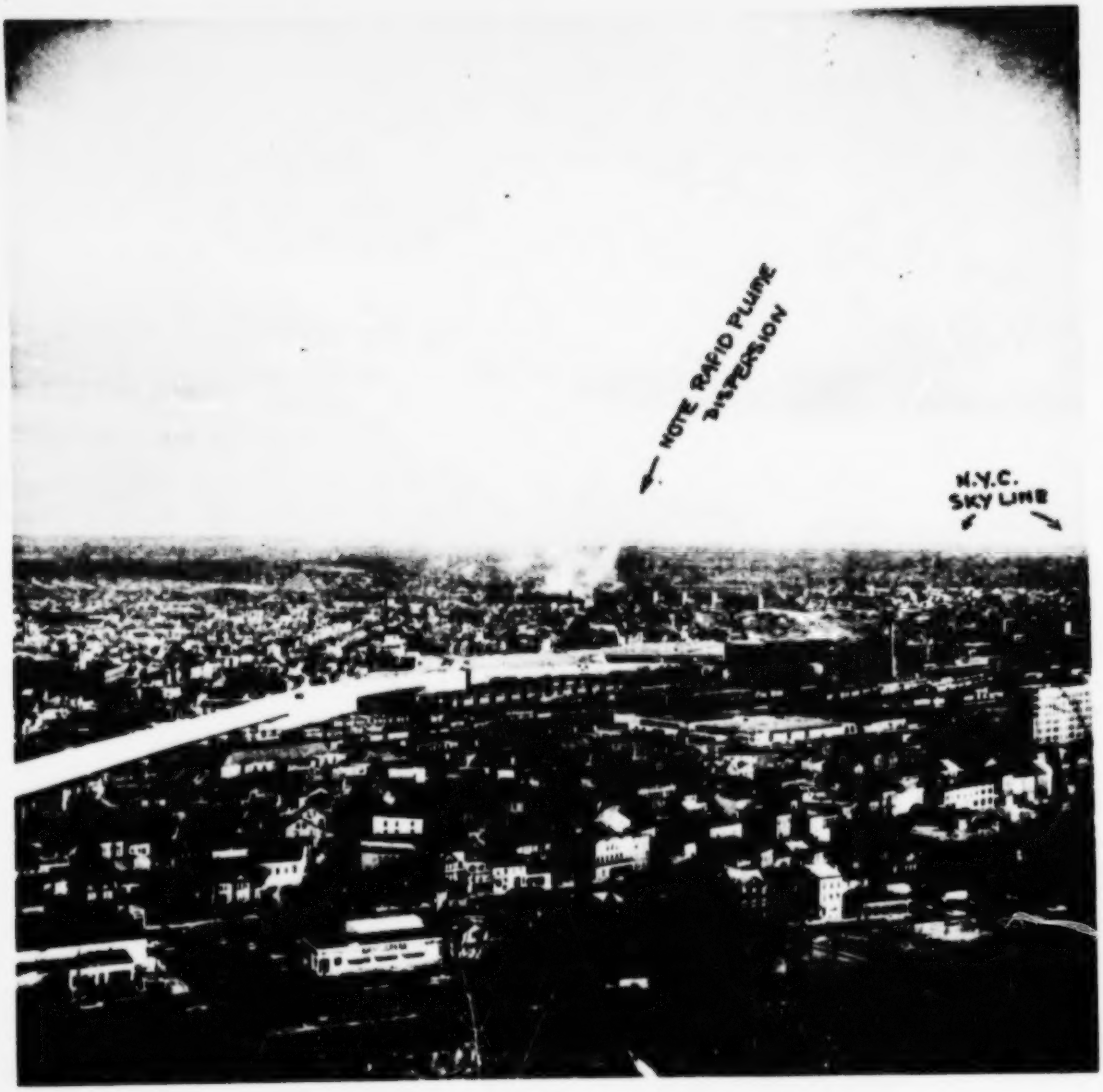
View from Garrett Mountain Reservation-Auto Overlook, elev. approx. 452' above M.S.L., looking ESE.

Smoke plume dispersing from an industrial plant located in the vicinity of Market Street and Lakeview Avenue in Paterson approx. 1.7 miles from observation point. Plant elevation approximately 65' M.S.L.

Wind velocity at Teterboro Airport: 070 @ 4 kts.

Wind in local vicinity: Variable to SW @ 0-4 mph.

Figure 3-6



QUAD-CITY SOLID WASTES PROJECT

November 30, 1966 1300 EST

View from Garrett Mountain Reservation-Auto Overlook, elev. approx. 452' above M.S.L., looking ESE.

Smoke plume dispersing from an industrial plant located in the vicinity of Market Street and Lakeview Avenue in Paterson approx. 1.7 miles from observation point. Plant elevation approximately 65' M.S.L.

Wind velocity at Teterboro Airport: 260 @ 15 kts.

Figure 3-7

SECTION 4

INFLUENCE OF GEOLOGY ON SITE LOCATIONS

Introduction

The general area under consideration for the following study is located in the northeastern sector of the State of New Jersey with contiguous areas in New York State. The area of particular interest includes all of Passaic County, together with adjacent portions of Bergen, Morris, Orange, and Rockland Counties. This smaller area is referred to as the study area (see Figure 4-1) in the remainder of this report. Because the study area is situated in the Passaic River Basin, aspects of this watershed pertinent to this study have been considered.

This study was made to present the geologic, topographic and hydrologic factors occurring in northern New Jersey, pertinent to the feasibility of locating solid wastes treatment and disposal facilities so that chemical and bacterial pollution of groundwaters and surface waters by solid waste disposal operations may be avoided.

Solid waste disposal works have as their primary purpose the safe and economic disposition of solid wastes. They must function in such a way as to provide the maximum service with the minimum risk to the inhabitants. While there exists a variety of methods available for the disposal of solid wastes, most of the methods in use today involve landfill operations to some extent. Processes such as composting, incineration and sanitary landfill, each employ such landfill methods in varying degrees. Effects on the surface waters and the groundwaters by ill-considered disposal operations can be serious. The region includes several watersheds which serve large populations with a supply of potable surface water. Pollutional loads if carried by surface runoff or by landfill leachings into the groundwater with subsequent drainage into water courses and reservoirs, present a potential threat to the quality of these surface water supplies.

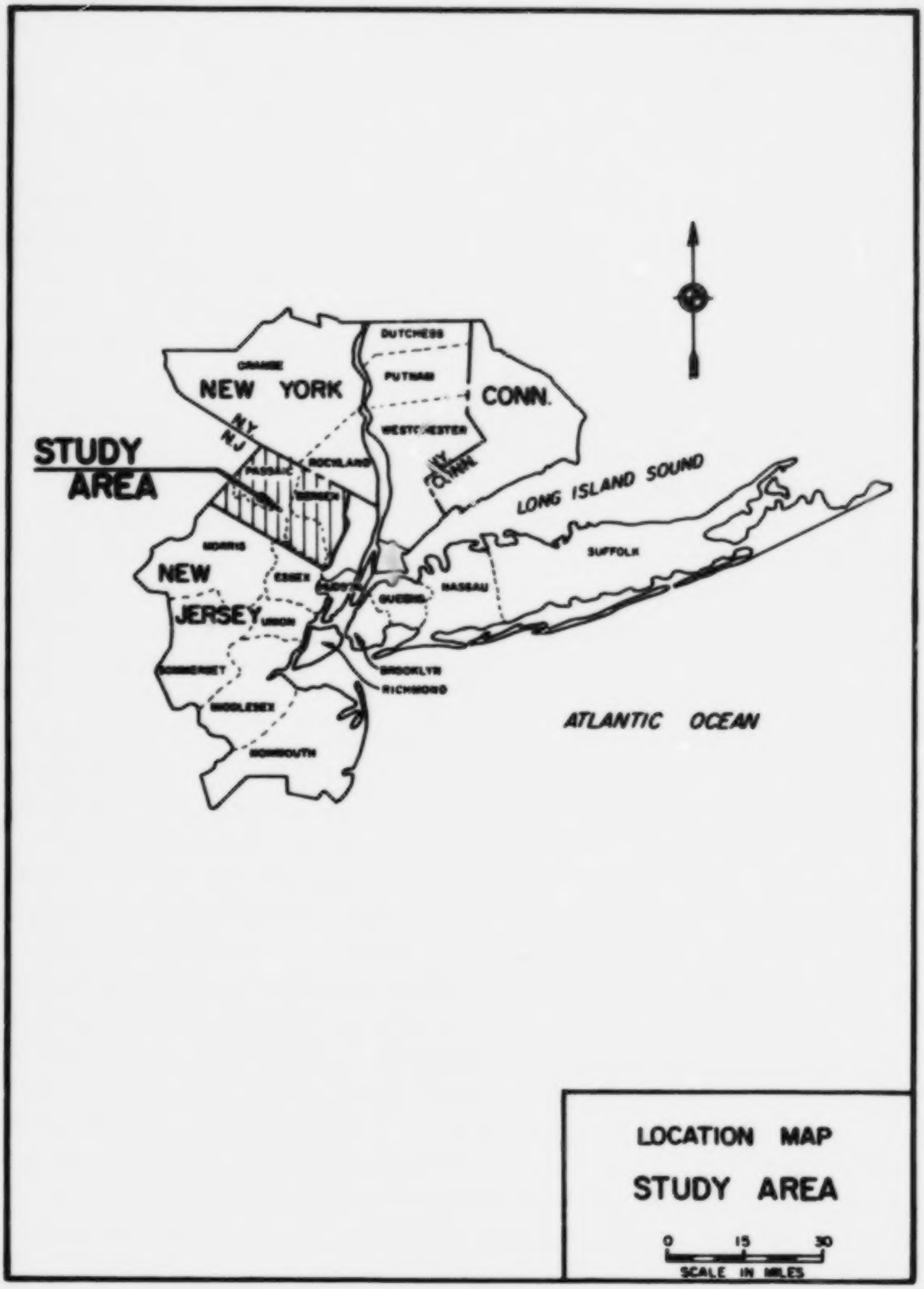

STUDY AREA
ORANGE
NEW YORK
DUTCHESS
PUTNAM
CONN.
WESTCHESTER
NY
NJ
ROCKLAND
PASSAIC
BERGEN
NY
CONN
LONG ISLAND SOUND
SUFFOLK
MORRIS
NEW JERSEY
ESSEX
HUDSON
QUEENS
NASSAU
UNION
SOMERSET
BROOKLYN
RICHMOND
MIDDLESEX
MONMOUTH
ATLANTIC OCEAN
LOCATION MAP
STUDY AREA
0
15
30
SCALE IN MILES

Figure 4-1

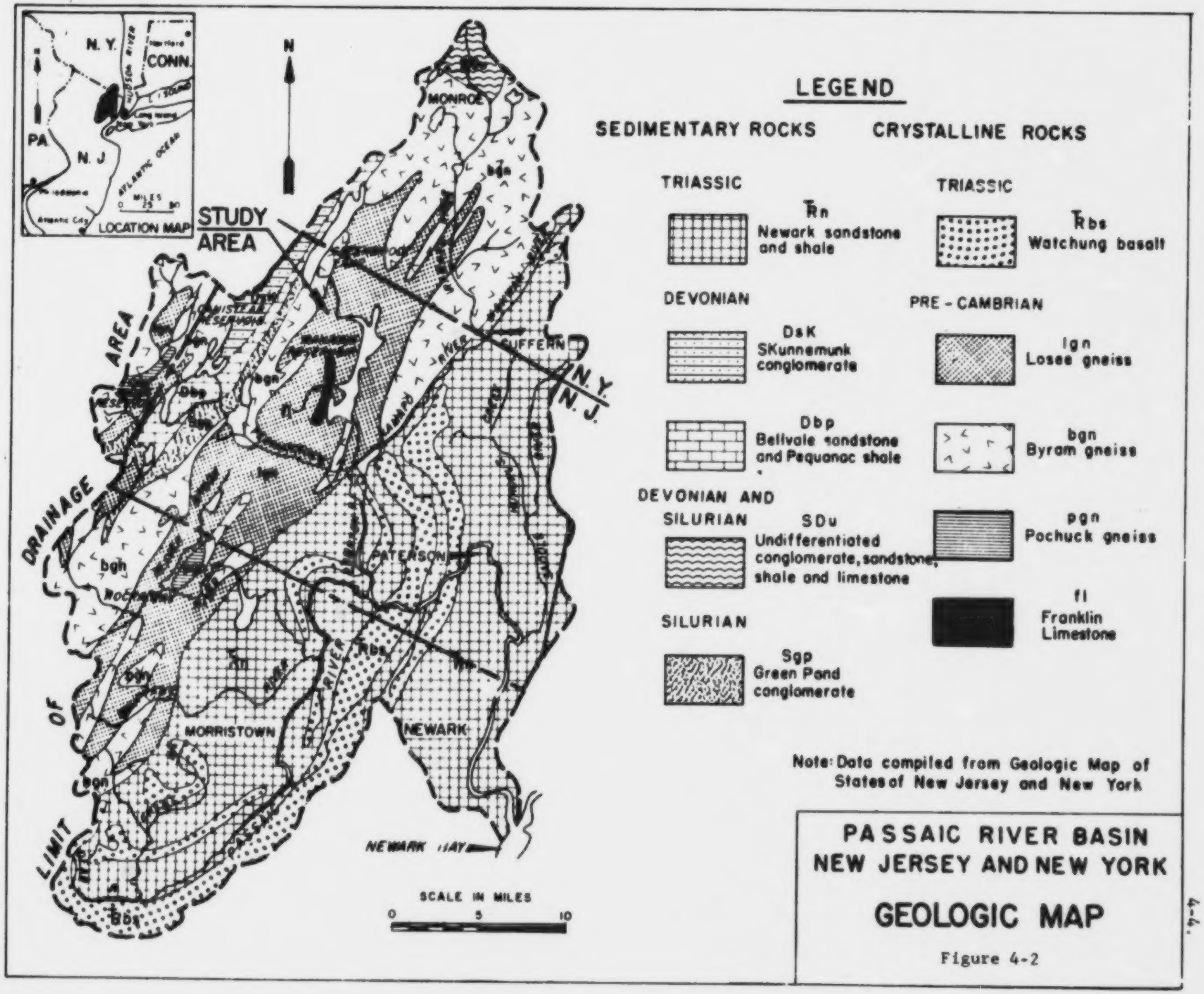
While exploitation of groundwater sources in the study area for water supply is not extensive, this area does contain or is adjacent to certain areas which do utilize subsurface supplies. Portions of Morris County, Bergen County, Essex County, together with areas near Pine Lake in Wayne Township, Passaic County draw supplies from wells. Thus, the pollutional effect of a landfill site on these aquifers should be considered.

Although effects of landfills must be given consideration, it should be understood that properly located and maintained landfills will not give rise to pollutional problems. Various studies have been conducted to ascertain the effects of ash dump leachate and sanitary landfill leachate on the groundwaters. These studies have been summarized in this report. Inasmuch as groundwater flow supplies stream base flow during periods of little or no precipitation, the results of such studies can give insight into the possible effects of landfill leachate on surface waters.

Topographical and geological characteristics, while being important as health and esthetic parameters, are also important as economic factors. They can be influential in the economy of construction and operation of solid waste disposal operations. Allowable earth bearing capacity, depth of unconsolidated cover, depth to bedrock, ease of excavation and water table elevations are some of these determining factors.

General Physiography of Passaic River Basin

Few areas in the world can equal New Jersey in the variation and complexity of its geology. New Jersey, and hence the Passaic River Basin, is situated on the Atlantic Slope of North America. New Jersey is divided between two major physiographic provinces. Approximately the northern one-third of the state lies within the Appalachian Province (see Figure 4-2). This major province is subdivided into six lesser provinces, three of which lie in the state. From east to west these three provinces are: the Piedmont Plateau, the Highlands, and the Valley



Note: Data compiled from Geologic Map of States of New Jersey and New York

PASSAIC RIVER BASIN
NEW JERSEY AND NEW YORK

GEOLOGIC MAP

Figure 4-2

4-4.

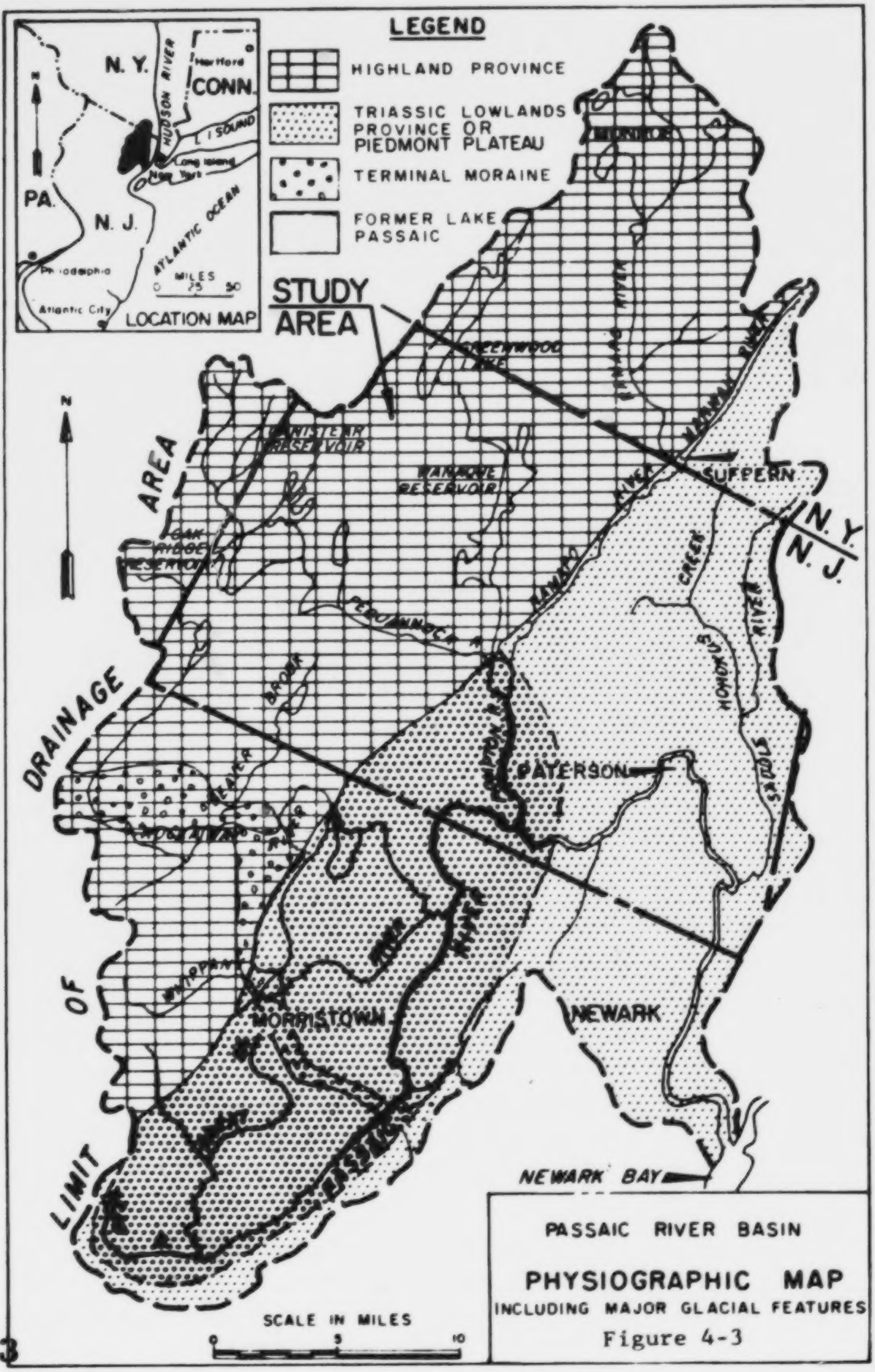
and Ridge (see Figure 4-3). The remaining area in southern New Jersey is situated in the Coastal Plain Province. The Passaic River Basin is approximately equally divided between the Highlands Province and the Piedmont Plateau Province. A general map showing the geological formations of northern New Jersey from the Passaic River west appears as Appendix 4A-1.

Highlands

The New Jersey Highlands occupies the area to the west of a major fault zone which passes in a northeasterly direction running from Bernardsville in the southern portions of the Passaic River Basin north to the Ramapo River Basin. Topographically, the Highlands are typified by numerous lakes, few valleys and rugged hills. The numerous lakes and reservoirs which are dispersed throughout the area include Greenwood Lake, Wanaque Reservoir, Canistear Reservoir, Oak Ridge Reservoir, Boonton Reservoir, Clinton Reservoir, Split Reservoir, Echo Lake, and others. Elevation of the rocky hills which dominate this portion of the province varies from 600 to 1,500 feet above sea level. The gradients of the terrains are generally steep, the average being greater than 20 percent. The Highlands, which is a broad upland region, is principally composed of northwest-southeast oriented valleys and hills. The valleys, predominantly deep and narrow, are cut chiefly in shales and limestone. The hills and ridges which are almost parallel are predominantly composed of crystalline gneiss and quartz. This group of metamorphic rocks comprises the major lithologic formations in this area of the Highlands and possesses highly developed irregular fractures.

The terminal moraine of the last Wisconsin Glaciation lies in the south of the Passaic River watershed. Glacial deposits, therefore, form a discontinuous mantle of unconsolidated material over the bedrock.

The steep slopes and generally impervious nature of the Highlands suggests a high degree of surface runoff from precipitation. The surface runoff flows generally parallel to



PASSAIC RIVER BASIN

PHYSIOGRAPHIC MAP

INCLUDING MAJOR GLACIAL FEATURES

Figure 4-3

the strike of the geologic formations. Annual runoffs of over 50 percent of the annual precipitation have been experienced for tributaries of the Passaic River that are situated in this province.

Piedmont Plateau

The Piedmont Plateau, also known as the Triassic Lowlands, occupies the area east of the fault zone previously referred to. The province constitutes a transitional zone between the Appalachian Highlands and the Coastal Plain. The terrain dips from an elevation of about 400 feet above sea level in the western portion of the Passaic River watershed to sea level at Newark Bay. The Piedmont area presents a low, hilly surface, broken by occasional ridges. The strike of these ridges trends northeast-southwest. The rock forms which underlie the Piedmont Province are principally sandstones and shales with intermittent lava flows. They were formed in the Triassic Period. Conglomerate, shale, sandstone, diabase and basalt of the Newark group, together with limited outcrops of serpentine and Manhattan schist make up the major consolidated formations of the province. Basaltic lava outflows form the ridges in the midwestern part of the province and are known as the First, Second and Third Watchung Mountains. Shales, sandstones, and conglomerate form the low rolling plains, which typify this plateau. The portion of this province which lies in the Passaic River Basin has been affected by the Wisconsin Glaciation. Terminal moraine, recessional moraine, drift, outwash, lake-bed deposits and till mask much of the rock formations underlying the province.

In general, the Triassic formations are extensively fractured and can sustain moderate to large yields of water. Artesian groundwater conditions occur in the lowland areas in the eastern extent of the province. In this lowland area the Triassic formations are overlain by glacial deposits of impervious nature. The condition is exemplified by the Great Swamp in the southern extremity of the Passaic River watershed. In the western portions of the Piedmont Province where the Triassic formations are not covered by a mantle of impervious material the water table is unconfined.

Surface drainage in the Triassic Lowlands is distinctly different from that in the Highlands. Flatter gradients and fewer valleys are typical of the eastern portion of the Piedmont and produce runoffs which tend to be predominantly elemental.

The Lithography of the Study Area

The study area is situated north of the terminal moraine of the Wisconsin Glacier and is approximately equally divided between the physiographic provinces of the Highlands and the Piedmont Plateau. The major lithographic units which occur throughout the study area are shown in Table 4-1.

Occurrence of Surface Waters in the Study Area

The Passaic River forms one of the major river systems in northeastern New Jersey. It drains a watershed of roughly 935 square miles. A brief description of the Passaic's major tributaries is listed below (see Figure 4-4).

The Saddle River rises in New York State and flows southward to its junction with the Passaic River at Garfield, New Jersey.

The Ramapo River flows southerly from its headwaters in New York State to its junction with the Wanaque and Pequannock Rivers at Pompton, New Jersey.

The Wanaque River is a branch of the Passaic River which rises in New York State and flows in a generally southerly direction to its junction with the Ramapo and Pequannock Rivers at Pompton, New Jersey.

The Pequannock River has its headwaters in New Jersey and flows southeasterly to Pompton, New Jersey, where it joins the Wanaque and Ramapo Rivers. From this intersection, it flows southward to its intersection with the Passaic River at Two Bridges. This latter segment of the Pequannock is sometimes

Table 4-1

Quad-City Solid-Wastes Project

Lithographic Units*
Passaic County Study Area

Era	Geologic Period	Geologic Formation	Type of Material	Physiographic Province
Recent		Alluvium	Clay, silt, sand, gravel	H, P
Cenozoic	Quaternary	Recessional moraine (Wisconsin)	Clay to boulders	H, P
Cenozoic	Quaternary	Stratified drift (Wisconsin)	Stratified sand and gravel	H, P
Cenozoic	Quaternary	Till (Wisconsin)	Clay to boulders	H, P
Cenozoic	Quaternary	Kames (Wisconsin)	Stratified silt sand and gravel	
Cenozoic	Quaternary	Lake-bed deposits (Wisconsin)	Stratified clay and silt	H, P
Mesozoic	Triassic	Border conglomerate	Conglomerate	P
Mesozoic	Triassic	Basalt	Fine Grained	P
Mesozoic	Triassic	Brunswick shale	Shale and sandstone	P
Mesozoic	Triassic	Stockton sandstone	Sandstone and shale.	P
Paleozoic	Devonian	Skunnemunk conglomerate	Conglomerate and sandstone	H
Paleozoic	Devonian	Bellevale sandstone	Sandstone and shale	H
Paleozoic	Devonian	Peguannac shale	Shale	H

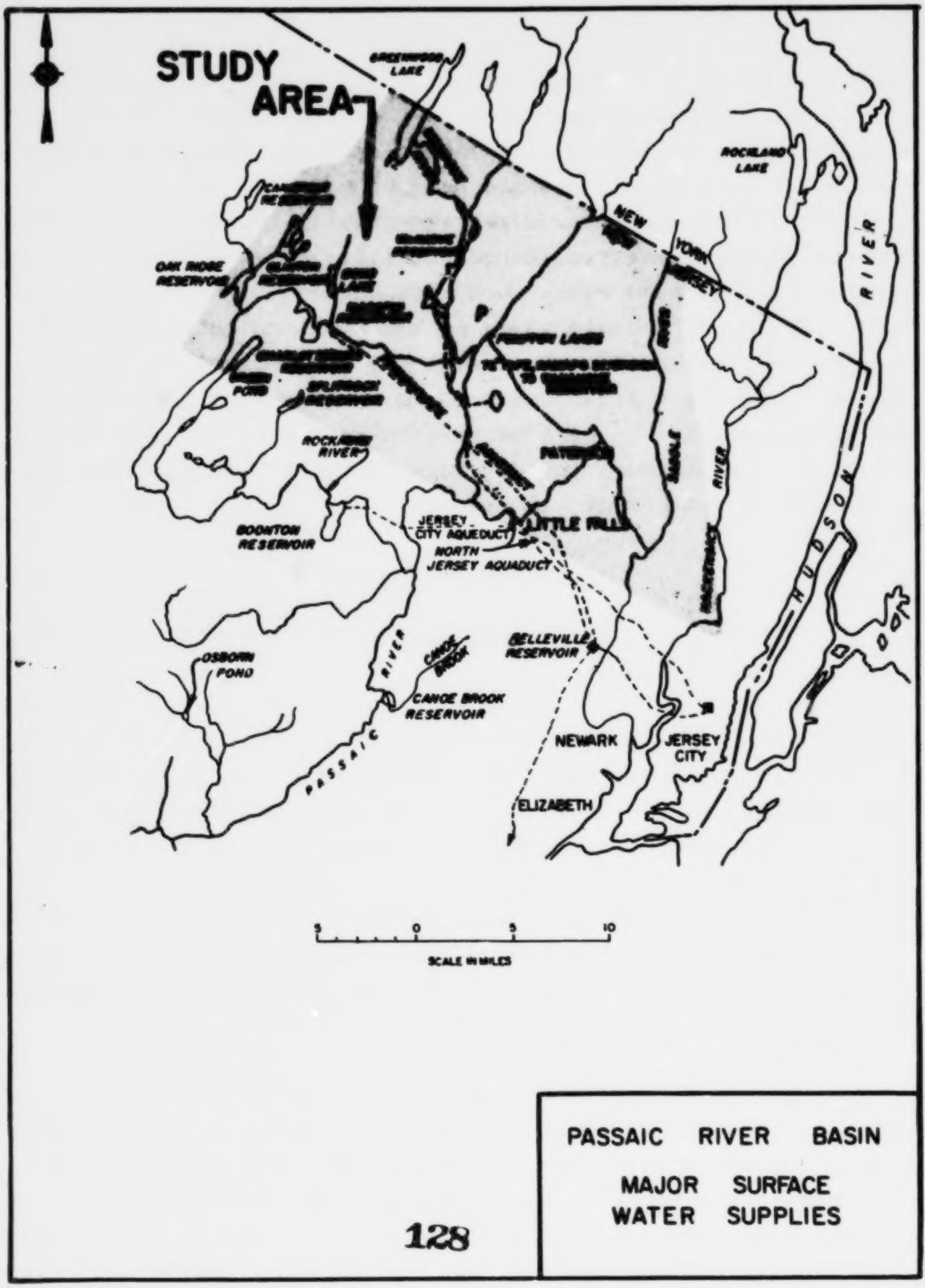
Table 4-1 (cont'd)

Era	Geologic Period	Geologic Formation	Type of Material	Physiographic Province
Paleozoic	Devonian	Kanouse sandstone	Sandstone and conglomerate	H
Paleozoic	Devonian	Dicker limestone	Limestone and sandstone	H
Paleozoic	Devonian	Longwood shale	Shale	H
Paleozoic	Silurian	Green Pond conglomerate	Conglomerate and sandstone	H
Paleozoic	Cambro-Ordovician	Kittatininy limestone	Limestone with shale and sandstone	H
Paleozoic	Cambrian	Hardystone sandstone	Sandstone conglomerate shale	H
Pre-Cambrian		Losee gneiss	Granitoid gneiss	H
Pre-Cambrian		Bryan gneiss	Granitoid gneiss	H
Pre-Cambrian		Pochuck gneiss	Granular gneiss	H
Pre-Cambrian		Franklin limestone	Limestone	H

H = Highlands Province

P = Piedmont Plateau Province

*Table taken from Report No. 1 - Engineering Soil Survey of New Jersey.



PASSAIC RIVER BASIN

MAJOR SURFACE WATER SUPPLIES

Figure 4-4

referred to as the Pompton River.

The Rockaway River rises in the northeastern sector of the Passaic River Basin and flows in an easterly direction to its intersection with the Passaic near Pine Brook, New Jersey.

The Whippany River flows easterly in the southern sector of the Passaic River watershed until its intersection with the Rockaway River near Pine Brook, New Jersey.

The Upper Passaic rises in the southern portion of the basin and flows northeast through the lowlands of the Great Swamp. This is a fresh water swamp which covers approximately 19 square miles. It is a natural ponding area and becomes inundated during floods. This storage provides natural flood protection during periods of high runoffs.

Water Supply Systems

Five water supply system resources are related to their watersheds as follows:

The Pequannock System

This system is owned and operated by the City of Newark and provides water to Newark, Bloomfield and Belleville. Several other small communities draw their water from this system at points along the aqueduct.

The system consists of five storage reservoirs in the Pequannock River watershed. The five impoundments are: Echo Lake, Canistear, Oak Ridge, Clinton and Charlottebury reservoirs.

The Rockaway River System

This water supply system is owned and operated by Jersey City. Hoboken, Lyndhurst and North Arlington as well as several minor consumers draw supply from the aqueduct. This system is located in the Rockaway River watershed and presently consists of two main impoundments; the Split Rock Reservoir and the Boonton Reservoir. Approval has been received by Jersey City from the State of New Jersey to increase its storage facilities in the Rockaway River watershed by the construction of an additional reservoir. It is to be located in western Morris County.

The North New Jersey District Water Supply Commission

This Commission administers the Wanaque-Ramapo water supply system. This system is owned by several owners in the following percentages:

City of Newark	40.50%
Passaic Valley Water Commission	37.75%
Town of Kearny	12.00%
Town of Montclair	5.00%
Town of Bloomfield	4.00%
Borough of Glen Ridge	0.75%

Water impounded in the Wanaque Reservoir is obtained from the Wanaque River and from the Ramapo River. At Pompton Lake waters of the Ramapo are diverted to the Wanaque Reservoir, on the Wanaque River, by a 72" diversion aqueduct and pumping facilities. An aqueduct extends from the Wanaque Reservoir to the Belleville Reservoir at Belleville, New Jersey. The Belleville Reservoir is a distribution reservoir and provides the interconnection between the Rockaway River system, Pequannock River system, and the North New Jersey system.

The Passaic Valley Water Commission System

The Passaic Valley Water Commission was organized by the Cities of Clifton, Paterson, and Passaic. Its function was to acquire and operate a system to supply potable water to the member municipalities. Presently this commission supplies water to Clifton, Paterson, Passaic, Harrison, Nutley, Prospect Park, Totowa, Garfield, Haledon, East Paterson and Lodi. The various sources of supply are described below:

a) North New Jersey Districts Wanaque-Ramapo system in which the Passaic Valley Water Commission owns 37.75%. The water is conveyed by two 74" lines from the Wanaque Reservoir to the Passaic Valley Water

Commission's tap. The tap consists of a 48" steel conduit which delivers the water to a filtration plant. After treatment, the water is distributed to the consumers.

b) The Passaic River supply. At a point just above Beattie's Dam on the Passaic River near Wayne, N. J., raw water is withdrawn via an intake canal. It is brought to the filtration plant mentioned above, and treated and distributed.

c) Permission has been granted to the Commission to allow the construction of a reservoir on Hayrock Brook. This impoundment will store the flood flows of the Pequannock River just below Ramapo-Wanaque-Pequannock junction.

The Commonwealth Water Company

This is a privately owned company which serves areas in the southern corner of the Passaic River Basin. Its supply consists of diversions from two impounding reservoirs on Canoe Brook and direct withdrawals from Passaic River. Canoe Brook is a minor tributary of the Passaic River flowing southward from Livingston to its junction with Passaic River.

Morristown, Boonton, Butler, Haledon and Bernardsville draw water from the Passaic River and its tributaries for a portion or all of their supply.

Effects of Sanitary Landfill Leachate

The Sanitary Engineering Research Laboratory at the University of California, in 1954, prepared a "Report on the Investigation of Leaching of a Sanitary Landfill." The two-year study was performed to ascertain the effects of water passing through a sanitary landfill on groundwater quality. The site was a sanitary landfill owned and operated by the City of Riverside, California. The on-site geologic conditions were a 7.5 foot thick landfill layer underlaid by a granular aquifer. The aquifer was approximately 15 feet thick and was underlaid by an aquiclude. The aquiclude was underlaid by another granular aquifer.

The test consisted of two phases. One phase ascertained the amount of leachate which passed through the 7.5 foot thick layer of sanitary landfill under normal rainfall conditions. During the 18 month period that this phase of the test was conducted, 18.7 inches of rainfall fell. No leachate was produced. The researchers reached the conclusion that, "Rainfall alone in this area will not penetrate a 7.5 foot thick landfill sufficiently to cause entry of leachate into the underlying ground water." This is attributed to high bacterial action and high evaporation rate typical of that southern California area.

Climatically, the study area is located in the humid continental climate zone. The climatic conditions are characterized by temperatures which vary between 0°F and 100°F, and an annual precipitation of 46 inches. Riverside, California, however, is located in a semi-arrid region in southern California with an average annual precipitation of less than 20 inches and a much higher average temperature. Thus the applicability of this conclusion to the study area due to the difference of climatic conditions is doubtful.

It can be reasoned that it is possible for precipitation to penetrate a sanitary landfill in the humid climate of northern New Jersey, particularly during the cooler seasons when evaporation and bacterial action are at a minimum and precipitation is high.

The second phase of the test consisted of artificially inducing leaching of a sanitary landfill. This was accomplished by dosing a sample with water. The leachate was collected and analyzed. Other pertinent aspects from the second phase of the report are herein represented: "A sanitary landfill, if so located, as to be in continuous contact with ground water, will cause gross contamination of the ground water in the vicinity of the landfill site."

Removal of contaminants such as chloride, sulfate, bicarbonate, alkalinity, sodium, potassium, calcium and magnesium will at first be very rapid. After the first year, the removal rates will be slowed considerably.

The dissolved materials which enter the groundwater will:

a) Have their greatest travel in the direction of flow.
b) Undergo vertical diffusion.
c) Be subject to dilution.

Bacterial decomposition of the fill will cause the formation of Methane (CH_4) and Carbon Dioxide (CO_2). The Carbon Dioxide will dissolve into the groundwater to a limited extent until equilibrium is shifted. This will result in large increases in hardness forming cations in the groundwater. The permeability of the limestone formation will increase.

Occurrence of Groundwater

Water exists beneath the ground surface in two states; vadose water and groundwater. Water which infiltrates the ground surface flows in a generally vertical direction responding to the force of gravity. As it percolates through the ground, a portion of the water adheres to the surfaces with which it comes in contact. This water is termed vadose water and it exists in the zone of aeration or unsaturated zone of the soil. The water which fills the voids and pores in the saturated zone of the soil is termed groundwater. Groundwater responds to pressure differentials and produces flow; whereas, vadose water will remain adsorbed on the particulate surfaces.

Groundwater can exist in granular geologic formation in the pores and voids between grains. Groundwater may also occur in consolidated formations when a continuous network of fractures, faults or interstices exists. The study area has aquifers of both the consolidated and unconsolidated forms.

Consolidated Formations

The consolidated formations which are encountered in the study area are also encountered in the adjacent areas of Morris County and Bergen County. Water supply studies conducted for Bergen and Morris Counties deal with the water-bearing properties of some of these formations. Consolidated formations occur in the study area as massive outcrops or covered by a variable layer of glacial material. Most of the consolidated formations which were formed in the Pre-Cambrian, Paleozoic and Triassic periods have been studied to some extent. It has been established that the gneisses, limestones, sandstones, conglomerates, basalt, and shales which are of common occurrence in the study area and in adjacent areas are extensively fractured and jointed and do contain and transport groundwater. In the study for Morris County (Gill and Vecchioli) it is stated that the limestones and gneisses of the Pre-Cambrian Age supply most of the groundwater for the northwestern two-thirds of the country. The Bergen County report indicates that the Triassic sandstones and shales that underlie 80 percent of the County represent a major potential source of groundwater. In general, these studies indicate that the wells which tap these formations have relatively low specific capacities.

The specific capacity of a well is the ratio of discharge to drawdown. While specific capacities may not be constant, a high specific capacity indicates a good yielding well. If high specific capacities are typical of wells located in a particular aquifer, it may be concluded that the aquifer has good yield. Yield of an aquifer depends on its porosity and permeability. High porosities indicate large volumes of water per unit volume of aquifer while high permeabilities indicate the ease with which an aquifer will release its fluid. A low specific capacity may be due to a low permeability, or a low porosity, or combination of both. Because of the nature of the fractures which exist in these consolidated formations, the permeability is high. Permeability is analogous to the velocity of flow through an aquifer. High permeabilities indicate high flow velocities. For comparison, typical flow velocities through the fractured formations in the study area may reach several hundred feet per day; whereas, typical velocities in unconsolidated formations in the region are ten to one hundred feet per year. Therefore, it may be concluded due to the specific capacities found in these aquifers that the volume of water stored is small.

It has been found that the extent of open fracturing in the consolidated formations which underlie the entire study area decreases with depth. The ability of the formations to store and transport water, therefore, also decreases proportionately with depth.

Vertical stratification of flowing water suggested by the variation of permeability with depth, and the low volume of water storage suggested by low specific capacities indicates only minor dilution potential for pollutants entering these formations.

Unconsolidated Formations

Granular materials usually have relatively high porosities and, therefore, can store large volumes of water. Volumetric storage is not the only parameter which is important for groundwater transport. The permeability represents the ease with which a deposit will give up its fluid. Mixtures of homogeneous deposits of clays, silts and extremely fine sand while capable of containing large storages of water do not release the fluid easily and, therefore, retard its flow. Sand and gravels generally provide smaller storages of water than the clays and silts, but usually have higher permeabilities. These coarse-grained deposits allow the easy passage of water.

Five types of granular deposits occur throughout the study area. They are: alluvium, glacial till, stratified drift, kames and lake-bed deposits. The internal drainage of each type of deposit depends on the predominant type of material making up the deposit and the way in which deposition occurred. The pertinent properties of these deposits are briefly described.

a) Alluvium - Materials in these deposits have been transported to their present location by flowing water. Deposition of this material has been caused by sedimentation. Due to this action, the deposits tend to be stratified. The grain sizes of such strata in the study area range from clays and silts to fine sand with some gravels. Alluvial deposits in the study area occur in close proximity to rivers, streams, and lakes. The thickness of these deposits may vary from 0 to 25 feet. The internal drainage characteristics vary from moderately poor to extremely poor. In these deposits groundwater may be anticipated from 0 to 3 feet below the ground surface. Surface runoff may be expected to vary from fair in the older alluvial deposits to extremely poor in the new deposits.

b) Glacial Till - This material is chiefly composed of heterogeneous unassorted, unstratified mixtures of materials which were transported by the glacial advance. The grain sizes vary from clays and silts to cobbles and boulders. In the study area, the internal drainage of these deposits may vary from fair to poor. Saturated soil conditions may be expected at from 1 to 3 feet below the surface. Surface runoff characteristics of these deposits vary from generally poor in the southern portion of the study area to fair in the north. Depth to bedrock may vary from 0 to greater than 20 feet.

c) Stratified Drift - Deposits are chiefly composed of relatively homogeneous stratified clay and silt with varying amounts of sand and gravel. These materials were deposited by waters flowing within or from the glacier. The internal drainage characteristics of these deposits vary considerably. Drift deposits which have little silt mixed in have good internal drainage characteristics, whereas, drift deposits with considerable amounts of fines have poor to extremely poor internal drainage. Because of the variable internal drainage characteristics, no general statement on the depth to the saturated zone can be made.

Surface drainage over these deposits can be expected to vary considerably depending on the grain size distribution and topography of the deposit. Depth to bedrock will generally range from 10 feet to greater than 20 feet.

d) Kames - Kames are low, dome-shaped stratified deposits of silt, sand and gravel formed by hidden glacial streams. The internal drainage of these materials is generally good to excellent. Due to the open texture of these deposits saturation may be expected only at considerable depths. Surface drainage, depending on topography, may also vary from good to excellent. Depth to bedrock is generally greater than 20 feet.

e) Lake-bed Deposits - These formations were deposited on the floor of the ancient glacial Lake Passaic during the Wisconsin glaciation. The material is composed chiefly of clay and silty clay with varying amounts of peat and organic muck. Surface and internal drainage of this material may be characterized as poor to extremely poor. Soil saturation may be anticipated from the ground surface to 3 feet below the ground surface. Depth to bedrock is generally greater than 10 feet.

Special swamp conditions exist in northern Passaic County and in certain areas south of Pompton Lakes. The condition which characterizes these swampy areas is one of thick organic muck deposits over fine grained glacial till accumulations which in turn are underlaid by Pre-Cambrian or Triassic bedrock. The surface drainage and internal drainage conditions are extremely poor. Water table conditions exist at the ground surface throughout most of the year.

Effects of Ash Dump Leachate

A study was conducted by the Sanitary Engineering Research Laboratory of the University of Southern California in 1952, to investigate the effects of ash dump leach on groundwater quality. This study was named, "Report on the Investigation of Leaching of Ash Dumps." Pertinent excerpts from the Conclusions and Recommendations are herein listed.

a) The percolation of natural precipitation or the movement of ground water through an incinerator ash dump will leach soluble salts and alkalies from the dump.

b) The average rate of penetration through a uniform ash dump during a period of greatest rainfall will be in the magnitude of 0.20 inches per day.

c) Chlorides and nitrates will be rapidly and completely removed by leaching. Sulfates will be removed more slowly. Calcium, magnesium, sodium, and potassium will be removed by leaching. However, it is unlikely that these cations will ever be completely removed.

d) It is recommended that incinerator ash dumps be located in an area which is subject only to percolation by precipitation. Caution should be exercised in the selection of a dump site to avoid funneling of leach waters into an inadequate volume of ground water.

e) It is recommended that ash dumps should be so located so as to insure against passage of ground water through them.

f) It is recommended that the unburned or partially burned organics in an incinerator ash residue be kept to a minimum. The anaerobic or aerobic decomposition of these organics causes the production of CO_2. The passage of free CO_2 into the leach and into the ground water increases acidity. This directly

> increases the passage of cations into solution. This is of particular consequence in limestone or other calcium bearing formations because of the increased hardness produced in the ground waters, and increased size of the fissures which exist in the formation. Thus, the velocity of flow of ground water through aquifer will tend to increase.

Comment

It has been established that utilization of solid waste or refuse disposal plant residue for landfills will leach pollutants by contact with water. These pollutants can contaminate the surface runoff over the landfill or the leach through the landfill. The close proximity of this study area to various surface and subsurface water supplies raises concern over contamination of such waters by runoff or leachate from a landfill located within the area.

Surface runoff in the western or Highlands portion of the study area tends to be much swifter than that in the eastern or Piedmont Plateau portion of the study area. If adequate measures are not taken to insure against contamination of runoff from precipitation which flows over the landfill site, nuisance conditions may arise. Contaminants which may find their way into the runoff over the landfill can either be suspended or dissolved solids. These solids act as substrate for biological growth and hence exert an oxygen demand (BOD) on the receiving waters.

The amounts of total nitrogen, chloride and coliform carried by surface runoff can be substantial. The natural means by which the effects of these pollutants are reduced are chiefly biological oxidation, chemical oxidation, and dilution. Dilution is possibly the most important of these mechanisms. In general, the time required for surface runoff to collect in surface water courses in the western portion of the study area is much less than that in the eastern portion of the study area. Hence erosion and the amounts of suspended solids which will be carried by elemental runoff, streams and rivers in the Highlands are greater than in the Piedmont Plateau province. Proper grading to prevent ponding of precipitation over the landfill site, adequate surface courses of relatively impermeable material over the landfill, proper erosion control of the surface course by stabilization with grass, and interception of surface runoff will alleviate most problems which may arise due to surface runoff.

Similar pollutional loads are carried by landfill leachate. The pollutional loads which are carried by the leachate of an ash dump landfill or a sanitary landfill may be eliminated or minimized to tolerable limits by a variety of naturally occurring self-cleaning mechanisms. The effect of these mechanisms can be maximized by the judicious location of the landfill site. Some of these self-cleaning mechanisms are filtration, adsorption, absorption, dilution, biological oxidation, chemical oxidation and ion exchange, of which filtration, dilution, ion exchange and biological oxidation are probably the most important.

The greatest degree of suspended solid filtration can be anticipated if the landfill is located within granular strata. Similarly, the greatest amount of dilution of pollutants is to be expected from a landfill located above a granular aquifer. As previously shown, the leachate of a landfill entering a consolidated aquifer will be diluted to a lesser degree than if it enters an unconsolidated aquifer. This arises out of the fact that the storage of water in a consolidated aquifer is much less than in granular aquifers and the vertical diffusion of pollutant in a consolidated aquifer will be minimized due to the nature of the fissures.

The detention time of pollutants entering a consolidated aquifer will be considerably shorter than the detention time of pollutants in an unconsolidated aquifer. Velocity of flow in consolidated aquifers may be measured in hundreds of feet per day; whereas velocity of flow in unconsolidated aquifers may be measured in several feet per year. The high velocity of water movement attained in rock formation is due to the channel-like properties of the fractures. The tortuous path that the flow must follow in granular formations prevents water movement from reaching high velocities and also accounts for superior diffusion of contaminants in the granular strata. The rate of water movement in consolidated formations, especially limestone, is subject to increases owing to the enlargement of fissure sides due to the action of biologically formed Carbon Dioxide (CO_2). Carbon Dioxide is formed when microorganisms oxidize the organics in the landfill.

Aquifers in northern New Jersey usually traverse relatively short distances. The extent of these aquifers is usually measured in hundreds to thousands of feet, as compared to aquifers in southern New Jersey where horizontal distances traversed by aquifers are measured in miles. Therefore, landfill leachate entering an aquifer will effect nearby surface waters in relatively short periods of time. The expected detention period of pollutants in a consolidated aquifer may be days or weeks; whereas the detention period in unconsolidated aquifers may be years.

In light of the foregoing discussion, it is recommended that any form of sanitary landfill be located so that it will never be in contact with the groundwater or with bedrock. It should be located in glacial deposits well above bedrock and the groundwater tables.

SECTION 5

SITE INVESTIGATION PROGRAM

Due to the sensitivity of the candidate sites investigation program, the sites identified and studied will not be discussed in this document. Nine sites were investigated in detail and another six sites were identified and cursory investigations were performed.

In developing the methodology for the site investigation program, certain ground rules were established. Early in the first year's program, the Commissioners decided that in order to give maximum flexibility to the staff, the sites under investigation by the staff would not be disclosed, not even to the Commissioners until such time as the system was developed, the authority established, and the selected sites were more thoroughly evaluated from the technical and cost basis. Land use and zoning for the four communities would be studied to assure the Committee that land zoned for residential would not be compromised. Sites were located without preference to community and in fact several sites were studied outside of the Quad-City area.

Maps of the sites were obtained. The Consultant provided aerial surveys for the entire lower Passaic County Area. In addition, engineering data relating to major sewer, water and electrical power utility lines were obtained from the appropriate sources. After cursory study of the above, the staff made inspections of the various candidate sites. These inspections consisted of traversing the site and the area immediately surrounding the site. Those items of significance were noted such as topography, ingress and egress, roads or highways, land use, buffer zones, utilities, groundwater, wind conditions, etc. If a site appeared to be of interest, then a more detailed investigation was initiated.

Tax records were searched to identify the present owner, assessed value, area of tract(s), and to obtain all pertinent data. From the tax maps, aerial photography and city maps, a plan of the candidate site was drawn up showing important topographical features, roads, utilities, etc. In addition to the map a short memo report was prepared on each site and forwarded to the Project Director and Consultant.

The sites identified were evaluated further by the Consultant with regard to meteorological conditions, logistics, etc. The data developed under the site investigation program are being further evaluated and will be made available to the Commissioners at the appropriate time.

The ultimate investigation of sites is contingent on the methodology finally selected by the Commission or the system for solid waste disposal demonstration.

SECTION 6

INVESTIGATION OF EXISTING DISPOSAL FACILITIES

During the first year program the staff, consultant and representatives of the Technical Advisory Committee inspected several disposal facilities. The facilities were investigated as applicable with regard to:

Land Use and Zoning
Site Access
Operations
Safety
Aesthetics
Utilities
Public Health Provisions
Cleanliness
Air Pollution Control
Water Pollution Control
Fire Protection
Personnel
Population Served
Construction Costs
Operating Costs
Innovations

Due to budget limitations, it was determined that only those facilities within a one day car travel would be inspected unless a facility offered some unique advantages or advanced the state-of-the-art. Priorities were given to incinerators and sanitary landfills inasmuch as it appeared that these methods would be more suitable to the Quad-City area. In addition, the staff investigated supporting equipment such as compaction that might become a part of the total solid wastes system.

Sanitary Landfills

The solid wastes collected in the Quad-City area are ultimately disposed of in private landfills in Lyndhurst, North Arlington, and Kearney, an area known as the Jersey Meadowlands, and a landfill known as Sharkey's in Pine Brook, Morris County, New Jersey.

Sanitary landfill is a method of disposing of refuse on land without creating nuisances or hazards to public health or safety by utilizing the principles of engineering to confine the refuse to the smallest practical area, to reduce it to the smallest practical volume, and to cover it with a layer of earth or inert materials at the conclusion of each day's operation or at such more frequent intervals as may be necessary.

The Jersey Meadowlands have been used for dumping for over 50 years. Until recently the State enforced few controls on these dumps. An increasing public pressure with regard to air pollution, aesthetics and resources management is now in evidence. The State Department of Health is applying more public health and safety controls to the operation of private landfills. Over 250 communities in New York, New Jersey and Connecticut deposit solid wastes in the New Jersey Meadowlands. Until other methods are provided, these landfills will continue in operation subject to ever increasing controls.

The staff inspected landfills located in Elizabeth, Newark, Kearney, North Arlington, Lyndhurst and Pine Brook, New Jersey. All are located in the Jersey Meadowlands except the one in Pine Brook which is located in an area known as the Great Piece Meadows-Hatfield Swamp, Passaic Middle Valley.

The terrain is low, flat and swampy. In the case of the landfills in the Meadowlands, it is recognized that riparian lands owned by the State are being encroached upon by these private operators. Actually the cover material is being dredged or removed by dragline from the estuaries making up the Newark Bay and Hackensack River systems.

Theoretically, the refuse is placed in trenches. The material dug from the adjacent trench excavation is used as cover material for the previous trench. The trenches form a series of longitudinal cells and undisturbed earth separates each of the trenches. Lifts are carried above the original ground surface. Trucks unload above the trench and provide additional compaction. Equipment used on the landfills includes: dozers, front-end loaders, draglines, back-hoe and power shovels, scrapers and auxiliary equipment such as water trucks to keep dust down and dump trucks for hauling cover materials.

Costs of sanitary landfill operation include:

Land Cost

Amortization of Capital Investment
    Equipment
    Alterations and Repairs
    Scale
    Personnel Facilities

Direct Labor

Tools, Supplies, Utilities

Routine Maintenance and Repairs

Administration and Overhead

Reclamation and Salvage (if any)

Land Resale

The landfill in Pine Brook charges $1.80 to $2.10 per ton of material dumped. The landfills in the Jersey Meadows have rate schedules which depend on many factors such as: duration of contract, type of trucks delivering materials, quantity of solid wastes and State enforcement pressures. Exact fee schedules were not obtained. Based on interviews with collectors using the Jersey Meadowlands, rates ranged from $5.00 to $12.00 per truck load or roughly from $1.50 to $4.00 per ton.

Some of the problems the staff observed are: gas and smoke production, differential settlement, underground and above ground fires, poor access road maintenance, and dust generation. Little or no consideration was given to aesthetics, future land use and accessibility.

Incineration

Because of the availability of suitable land for sanitary landfills in the northern New Jersey area, more specifically the Meadowlands, there has been little technical and economic justification for incinerator plants. Now, with public pressures for improved methods of waste disposal, increasing land values and public health factors, many of the communities using the landfills in Bergen County are considering incinerator facilities.

Incineration is the chemical process of burning solid, semi-solid, liquid or gaseous combustible wastes to carbon dioxide, water vapor and other solid or condensed phase products of combustion. The residue (unburned materials, condensed phase products of combustion and inerts) must be hauled away and deposited in a landfill.

The staff inspected the following plants:

1. Jersey City Incinerator, New Jersey
2. Ewing Township Incinerator, New Jersey
3. North Hempstead Incinerator, New York
4. Center Hill Incinerator, Cincinnati, Ohio
5. Delaware County Incinerator, Media, Pennsylvania
6. American Design and Development Experimental High Temperature Combustion, Whitman, Massachusetts

The plants were considered with regard to the following items:

On Site Roads
Access Roads
Land Use
Aesthetics
Overall Site Plan
Floor Plans
Employee Facilities
Communications
Fire Protection
Accident Prevention Safety
Operations Records
Maintenance
Area Sanitation
Building Sanitation
Number of Employees
Capacity
Weighing Facilities
Truck Apron
Unloading Area
Pits and Capacity
Refuse Segregation
Bridge and Crane
Furnace
Temperature Control
Residue Quality
Air Cleaning Equipment
Emission Quality
Salvaging
Vector Control
Water Pollution
Yard Equipment
Construction Costs
Operating Costs

Extensive technical, construction and operating costs data were obtained. Construction costs ranged from $2,600 per ton day for Ewing Township to over $10,000 per ton day for the North Hempstead Incinerator.

Table 6-1 provides a summary of cost per ton for the plants for which data were available.

The ASME Incineration Symposium Proceedings has additional cost data available. Based on preliminary estimates, a suitable plant for Quad-City will cost approximately $8,000 per ton day exclusive of land costs and costs related to other than normal air cleaning procedures.

Table 6-1

Quad-City Solid Wastes Project

Summary of Incinerator Cost Data

Plant	Ton/Day Capacity	$ Plant Cost	$ Cost Per Ton/Day	Amort.	Cost per Ton Oper.	Cost per Ton Total
Ewing	250	650,000	2,600	3.17	2.60	5.77
Delaware County #3	600	2,218,075	3,700	1.22	2.93	4.15
Jersey City	600	*	*	*	*	5.00
North Hempstead	*	*	10,000 +	*	*	*
ADDC - Melt-Zit Process	*	*	*	*	*	*
New York City (average)	*	*	*	*	6.67	*
Detroit	*	*	*	*	4.30	*

*Unavailable

Composting

The staff had interviews with five companies involved in composting. Until it can be demonstrated that a market can be developed for the compost, this method of disposal will be assigned a lower priority.

The four basic methods the staff studied are: (1) Dano System, (2) Rasping System, (3) Van Maanen System, and (4) Hammermill System.

The Dano technique consists of two drums; one big drum rotating slowly to mix the refuse and one drum rotating more quickly for grinding the substances. The grinding drum consisted of steel bars with slits between them and was enveloped by a large rotating screen. Particles trickling out through the slits and holes were fermented into compost. In 1961-1962, the Dano people introduced a new machine, the biostabilizer. Instead of the two drums, one large, slowly rotating drum is used. The refuse remains in the drum for several days, if possible five days. Air is blown through the drum, the compost is moistened and turned over through the rotating movement. Fermentation begins within a few hours and a fine dark compost is obtained in a few days. The product is screened and the coarse part thrown away.

In the rasping system, the refuse is disintegrated in a large rasping machine. Because of disintegration, the refuse tends to lose much of its odor and disagreeable quality. Allegedly, it does not attract flies or rodents. Since extensive power is used in the rasping machine, it costs more per ton to operate.

Refuse is heaped in high long rows and moistened in the Van Maanen System, a technique used in the Netherlands. It is decomposed by bacteria and molds. After bacterial decomposition, which takes six months, the only after treatment required is to remove or shred the hard and unfermented parts. The Van Maanen System requires extensive area. The heaps of refuse are unsightly and have an unpleasant odor. Flies and rats must be combatted, but in a moderate climate, vector control presents few problems.

The Hammermill System is quite similar to the rasping technique described above, except it uses a high-speed hammermill to shred the refuse.

Before compost can be used as a soil conditioner, impurities such as large and small particles of glass, pottery, iron, plastics, rubber, leather, etc., must be removed. Most of these impurities can be removed by screening the compost through 3/8" diameter or smaller holes.

The staff received capital cost data for a 300 ton per day plant. Exclusive of land, that unit cost was $3,000,000 or approximately $10,000 per ton capacity. Cost per ton of refuse processed was estimated to be $5.00 to $6.00 per ton. A 300 ton per day plant will produce approximately 170 tons/day of compost. The demand and selling price of compost would require an in-depth marketability study.

Other Systems Investigated

The staff investigated in addition to the above, rubbish grinding, salvaging, compaction, shredders and combination of shredders and composting. It was concluded that these techniques were only partial solutions.

In a garbage grinding station, garbage trucks dump their loads in a pit and the material is then fed into the grinder. A settling chamber is used for removing the grit and metal particles, and the remaining slurry is directed to the trunk sewer.

Shredding and compaction are methods of reducing the volume of the solid wastes thus increasing the capacity of the garbage trucks and other hauling vehicles and increase the life span of the sanitary landfill.

The staff found several instances where salvaging proved to be highly successful. During our industrial survey, it was found that cardboard, paper, rags, skids, wood, ferrous and non-ferrous metals, bottles, etc., were being salvaged and at a profit.

High Temperature Combustion Process

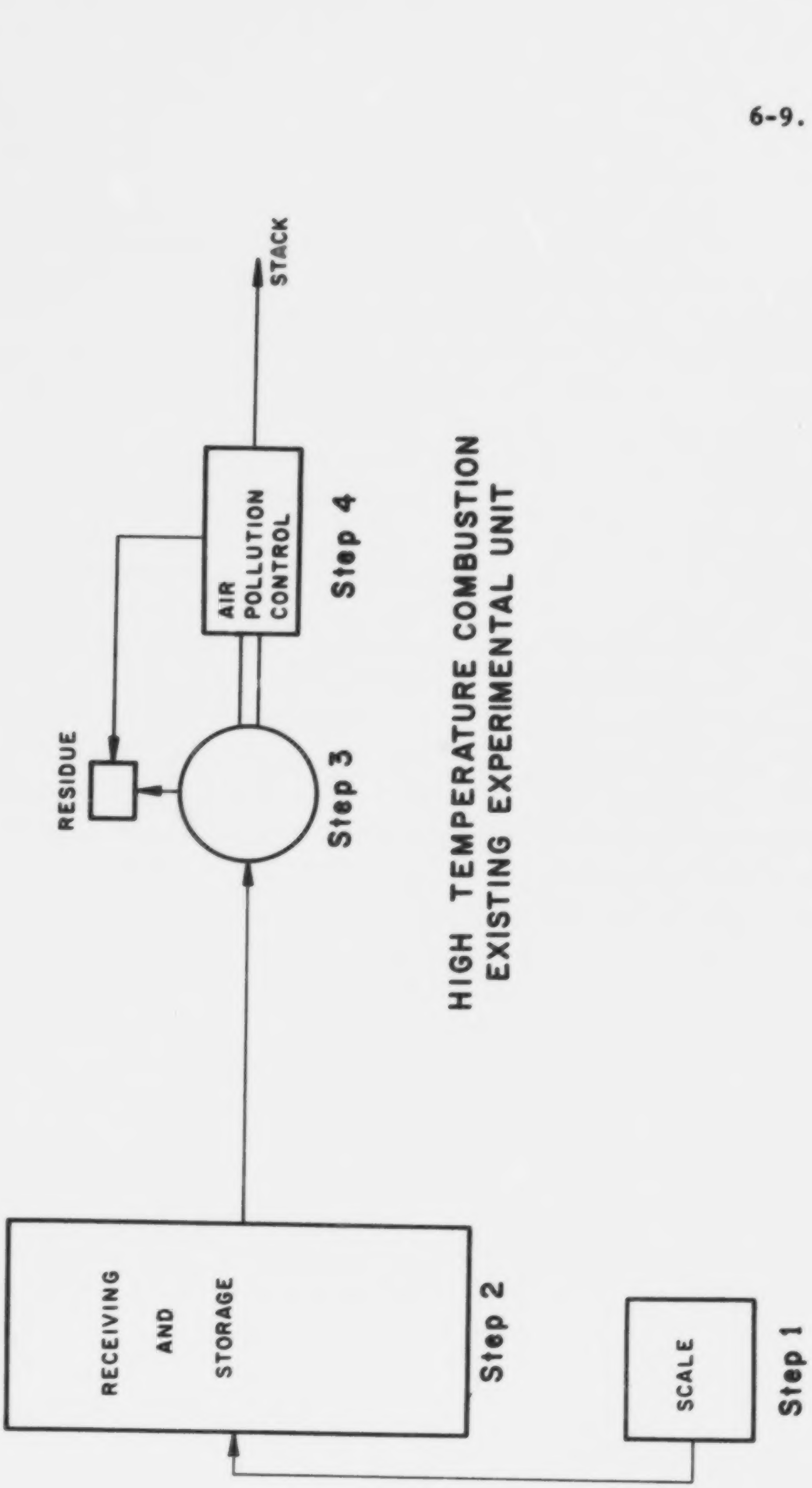
The Melt-Zit System relates to a high-temperature waste disposal process for municipal waste, such as combustible refuse or trash, including paper products, garbage and all other organic materials, as well as non-combustible materials such as glass, tin cans, bicycles and the like. More specifically, the Melt-Zit Destructor incorporates the combination of a new type of combustion air apparatus for extremely efficient and uniform combustion and reduction of all organic and inorganic material in the bed of the Destructor with an efficient new method of removal and handling of the fused residue. The Melt-Zit System also incorporates other combinations of novel means for effecting a most efficient economical apparatus for disposing of all municipal refuse, including means for controlled charging of the Destructor units. A diagram of the process flow in existing experimental system is shown in Figure 6-1.

Preliminary estimates of construction costs have indicated about $4500 per ton/day capacity and an operating cost of about $3.30 to $3.40 per ton.

Rail Haul and Sanitary Landfill

Since local landfill sites are limited, there has been a number of investigations of a combination of sanitary landfill at some distant point and rail haulage of highly compacted solid wastes from a central transfer station located at railside. This principal is an extension of existing practices wherein wastes are transferred to large capacity truck-trailer units and hauled some distance to landfill sites.

The American Public Works Association is presently undertaking a research demonstration project to investigate the feasibility of rail haul-landfill operations. Westchester County, New York is likewise investigating the feasibility, practicality and cost of such an undertaking. The City of Philadelphia has been investigating this avenue of solid wastes handling.



PROCESS FLOW CHART

Figure 6-1

The system, as presently conceived, involves a transfer station at railside that would include a pressure compaction unit bringing the refuse to from 1200 to 1800 #/cy (a compaction ratio of 3 to 5 times the original weight volume ratio at street side). The material would then be bound in some fashion, probably a bailing operation, and loaded directly on to cars by conveyor system or crane lift.

Multiple car trains would then carry the day's waste production to an isolated area having low land value and little or no local population in the immediate vicinity. Remote mountain areas, strip mines, abandoned quarries and similar locations have been suggested.

At the site a sanitary landfill operation would then be practiced with the compacted material transferred for rail to fill site.

Early estimates of this type of waste disposal have indicated an operating cost of $4.00 to $5.00 per ton for handling from transfer station to final disposal. Land values have not yet been estimated, but one of the principle elements of the plan calls for low cost land.

SECTION 7

STATUS OF THE FORMATION OF A LEGAL REGIONAL AUTHORITY

In 1961 the three cities of Paterson, Passaic and Clifton had joined in a Tri-City survey of refuse collection and disposal prepared by the Research Division staff of New York University. No action was taken at that time on the recommendations made in that report.

In 1966 the Mayor of Paterson was alarmed by the rapidly rising costs of solid wastes disposal and the persistent rumors of the imminent closure of sanitary landfills in the Jersey lowlands. He called for a revival of the 1961 effort and invited the participation of Wayne, a rapidly expanding area to the north and west of the three cities. The first meeting was held on January 26, 1966 at which the Mayors of the four communities joined themselves as an ad hoc committee and assigned the Chairman of the Board of Public Works of Paterson the task of defining the problems, needs, and possible sources of help.

By March it was learned that the State of New Jersey and the Federal Government were actively searching and discussing the regional approach to solid wastes disposal. Chapter 48B Section 40 of the New Jersey State Laws provided the permissive legislation for the formation of regional authorities, and the interpretation of Title II Section 204 (A) of the U. S. Public Law 89-272 suggested that funds would be available for a demonstration grant. Research indicated that priority of approval would be given to those communities which intended to demonstrate some new method or procedure in the disposal of solid wastes. These demonstrations could be on an engineering, operational, or administrative base but in the latter instance there would be required several municipalities, or a regional area, for the purpose of testing the administrative technique.

The first step was to update the 1960 Tri-City Report and add Wayne making a 1966 Quad-City Report. Next a technical advisory committee consisting of the municipal engineers and health officers of each community was appointed and in a series of meetings close liaison was established with the New Jersey State Board of Health and the New York Regional Office of Solid Wastes, Department of Health, Education, and Welfare. By May 31, 1966 still acting as an ad hoc committee and using the updated studies and reports as documentary evidence of readiness and ability to proceed, an application to the Federal Government for a grant was made.

By June 10, 1966 the grant was approved. The ad hoc committee immediately met to appoint the project director with power to negotiate a contract with Professor William T. Ingram, who would be retained as Consultant.

During July the project director had the governing body of each community pass the following resolution formally establishing and joining a Quad-City Solid Wastes Committee and outlining in brief the goals defined in the Federal grant.

WHEREAS, the Cities of Clifton, Passaic and Paterson and the Township of Wayne have been working together to attempt to develop a means for constructing, administering and operating a regionalized solid wastes disposal establishment for all four communities;

WHEREAS, said four communities have established for this purpose the Quad-City Solid Wastes Committee;

WHEREAS, it is necessary for this community to formally join said Committee and appoint an official representative thereto and to establish a term of service for such official;

WHEREAS, said Committee has applied for and has been granted a demonstration grant in the amount of $50,000 by the Public Health Service of the United States Department of Health, Education, and Welfare, for a period of one year commencing June 1, 1966, which grant is numbered 1-D01-SW-00026-01;

WHEREAS, the purpose of said demonstration grant is to finance a project which has as its objective the following:

1. To evaluate, develop, and demonstrate practices involving a combination of municipalities having a common problem of solid wastes handling.

2. To establish the means for administering and operating a regionalized disposal system.

3. To correlate a regional program with a state program and provide basic data to the State Health Department in furtherance of its long range solid wastes disposal planning.

4. To construct and demonstrate a pilot operation selected as best for the region.

5. To encourage regional solid wastes handling for all urban areas of Passaic County through demonstration or a program applicable for four municipalities of the County.

WHEREAS, the total cost of said project shall not exceed $75,000; and

WHEREAS, it is necessary for the four communities to accept the said grant and to agree to pay an equal share of the cost of said project in excess of the amount granted;

NOW THEREFORE, BE IT RESOLVED BY ______*______ that the ______*______ shall and does hereby join the Quad-City Solid Wastes Committee to be composed of representatives of the Cities of Clifton, Passaic, Paterson and the Township of Wayne for the purpose of partaking in the project described above;

BE IT FURTHER RESOLVED that the term of existence of said Committee shall be for a period of three years commencing on the 1st day of June, 1966 and that such term may be extended by further resolution of the member communities of said Committee;

BE IT FURTHER RESOLVED THAT ______***______ be and he is hereby appointed as official representative of ______**______ to said Committee for a term of three years commencing on the 1st day of June, 1966 and serve until his successor is appointed and qualifies;

BE IT FURTHER RESOLVED THAT the ______**______ does hereby accept the official demonstration grant No. 1-D01-SW-00026-01 in the amount of $50,000;

BE IT FURTHER RESOLVED THAT the ______**______ does hereby agree to provide to the Quad-City Solid Wastes Committee 1/4 of the total amount of the balance of the cost of said project which exceeds the $50,000 granted, the total of which said balance shall not exceed $25,000 and which may be provided in cash or services; and

BE IT FURTHER RESOLVED that in the event only three of the four communities involved in said Committee shall pass a resolution similar to this then and in such event the ____**____ shall contribute 1/3 of the total amount in cash or service of the balance of the cost of said project which exceeds the $50,000 granted, the total of which said balance shall not exceed $25,000.

*Insert herein the name of the body adopting this resolution.
**Insert herein the name of the community.
***Insert herein the name of the person designated to represent the Community on the Committee.

Introduced by ______________

Adopted ______________

____
Mayor

Attest ______________
City Clerk

At a meeting on August 4, 1966 the ad hoc committee was disbanded and the permanent committee was appointed in accordance with the above resolution.

During the next nine months the staff and consultant collected voluminous data and criteria for a solid wastes systems analysis. As the work progressed it became increasingly clear to the participants that the regional concept represented the best possible approach to the problem and that it would be quite difficult for each community to operate independently.

Having been convinced that formal and legal regionalization was necessary the Committee took the first step in that direction. An ad hoc legal committee composed of the City Counsels of each community was formed in May, 1967. They were assigned the task with the advice of the Project Director and Consultant of drawing up the articles of incorporation of an autonomous body to be known as "The Lower Passaic County Solid Wastes Management Authority." This Authority would have as only part of its power the right to:

1. Acquire by any means (including condemnation) personal or real property.
2. Negotiate contracts and agreements.
3. Sue and be sued.
4. Receive State or Federal Aids or Grants.
5. Apportion costs and expenses based on valuation, population, or other factors.
6. Other powers.

There is a long history of adverse public opinion in northern New Jersey to the formation of authorities because of the tendency of such bodies to become arbitrary and encroach on home rule. As recently as five years ago, a sewer authority was rejected in Paterson. Quad-City communities have on several occasions been forced to seek relief in Court over the actions of an area water authority.

Progress, therefore, on the formation of the Solid Wastes Authority has been torturously slow. Nevertheless, knowing full well that the clear objective of Public Law 89-272 is to support demonstrations of new procedures and knowing full well that the grant is based on the new technique of regional administration, there has been a strong influence to compromise. Agreement has been reached on many points that normally might preclude the formation of an Authority. For example, it has been agreed that:

1. All communities would have one member and one vote regardless of size or population.
2. There must be a unaminous vote for the site of any destructor plant.
3. Any community could withdraw from the collection service and perform this operation themselves.

As of this writing the weight of evidence continues to indicate that as soon as the professional staff completes their recommendation on a system of solid wastes management acceptable to the four communities, the legal authority will follow shortly. Meanwhile the ad hoc legal committee is continuing its work despite the fact that the membership of the committee has undergone fifty percent change because of new administrations in Paterson and Passaic.

SECTION 8

DISCUSSION OF INFORMATION

While much of the information has been discussed in its context, it is appropriate to review and discuss some aspects of the information in summary. The underlying theme of this entire study stems from a statement contained in the 1961 Tri-City report:

> "To continue the practice of independent collection and disposal of refuse by the three cities is an anomaly. Water services have already been regionalized, sewage and liquid waste disposal services are in the process of being regionalized. Refuse handling must surely follow that trend to avoid innumerable technical problems associated with the ultimate disposal of solid wastes and to conserve public funds by efficient management of a mandatory public utility service."

This position was reaffirmed by the consultant in 1966 in his report updating the 1961 report. It was incorporated into the objectives of the project and has been pursued vigorously throughout this study.

The first year of work brought to completion three assays of municipally collected solid wastes in the four communities. A fourth assay is needed to complete the series. Assays have brought to attention the fact that paper is a major component of both municipal and industrial solid waste (45.63% and 42.72% respectively).

It is apparent on the basis of composition analysis that there is much material that is selectively non-compatible with any single treatment method. For example; assuming that segregation were feasible, about 25% of the municipal waste would be excluded from wastes brought to incinerators and hence, require handling in some other fashion. On the other hand, high temperature combustion (HTC) could handle many of the excludable items since, at high temperatures, the materials would fuse and melt. Nearly 94% of the municipally collected material could be handled by HTC processing. The position on industrial waste handling is also attractive. Using the composition analysis of industrial waste and an assumption that materials could be segregated if necessary, 89% of the industrial waste could be handled in HTC compared with an estimated 68% by incineration.

The conclusion based on this analysis is that of the 6.05 #/capita/day combined municipal and industrial wastes, 72% of the material would be considered processable by incineration and 91% would be considered processable by HTC.

It has been estimated by further analysis that at least 20% of the incineration charge must be handled a second time as incinerator residue. Thus, with incineration, the material to be handled amounts to at least 1.2 tons for each ton of waste processed. Furthermore, that additional 0.2 ton requires a disposal operation similar to landfill for between 1 and 1.5 cubic yards per ton processed.

The residue from high temperature combustion is molten as it leaves the burning chambers, is granulated in water and is inert material. It can be used as ballast, concrete aggregate, asphalt paving filler, roadbed fill, and for most of the purposes that coarse sand or fine gravel might be used. It therefore requires no special processing or handling other than having it removed from the treatment plant. The material amounts in quantity to 0.03 ft^3 per cubic foot of refuse charged or 2.96 $\#/ft^3$ of charge. This residue is comparable to incinerator residue in pounds remaining after processing but is much more dense. The cubage occupied is relatively of low order. That is; each ton burned produces about 400 pounds of residue which in volume amounts to about 4 ft^3 or 0.15 cubic yards per ton processed.

Air pollution potential of the two processes is considered to be about equal. The air ventilation system affecting the Quad-City region is such that any stack emissions emanating from the vicinity of the valley floor must be subjected to severe review from the standpoint of air cleaning. It is therefore anticipated that specialized air cleaning procedures will be required for either process.

Heat recovery is possible in either process. Wetwall heat exchange has been demonstrated in newly constructed incinerators with the promise of 2.5 to 3 pounds of steam per pound of refuse. The increased temperature differential developed by 2800 to 3100°F firebox temperature in HTC is substantial and demands attention from the viewpoint of more direct conversion of heat energy into power.

The case for a combination of long haul from centrally located transfer stations to a distant sanitary landfill site should be considered as an alternative to any combustion process. It now appears unlikely that any landfill site within the four communities or even in lower Passaic County could meet rigid criteria that must be applied to such sites designed to handle 1,000 to 1,500 tons per day over a usable life of 20 to 25 years.

Long haul with transfer stations and compacting or shredding equipment to reduce volume and increase density of the solid waste to be handled is already being examined critically by the City of Philadelphia, Pa. and the County of Westchester, N. Y. The American Public Works Association has initiated a project to explore the feasibility of this handling method. The Quad-City region has both rail and express highway outlets that might be used to transport solid waste 100 or more miles to sites that could satisfy landfill criteria. Such a methodology might offer an interim solution to the handling of all waste products of the region or might have some advantages in providing for the ultimate disposal of that part of total waste production that would be objectionable in any of the combustion methods.

While composting should not be condemned as a process it has shown little potential as a method meeting the needs of urban areas in a metropolitan locale. It has been estimated that 31% of the municipal and industrial wastes of Quad-City either would be diverted or would require subsequent salvage or disposal operations. Sanitary landfill would of necessity be a companion operation if composting were employed.

In addition the end product of composting would require some form of ultimate disposal. Marketing opportunities in this urbanized area are such that composted materials might require extended transportation at increased cost to reach areas of sales potential. At this writing, composting appears to be a poor fourth choice as a primary treatment method.

Preliminary estimates of construction costs have been made for incinerator, HTC and composting. Incineration costs have ranged from as low as $2,600 per ton to $10,000 per ton. Estimates on HTC range from $3,500 to $5,000 per ton. Composting construction in one instance was estimated at $10,000 per ton.

Operating costs have been difficult to establish. Incinerator data range from $2.60 to $6.67 per ton. HTC operation has been estimated at $3.00 to $3.40 per ton. Composting has been estimated at from $3.00 to $4.00 per ton. Landfill has ranged from $1.50 to $4.00 per ton. Long haul-landfill has been estimated at $4.00 to $5.00 per ton. These data depend on the items that have actually been included in cost accounting and may reflect charges ranging from direct labor and equipment to allowances for overhead supervision, maintenance and repair and other indirect costs.

Recommendations

The consultant has reviewed the developments of this year's project activity and has offered the following specific recommendations:

1. Completion of a fourth assay to obtain a four season composite of municipal solid wastes.
2. Investigation of the following methodologies in detail:
    a. High temperature combustion.
    b. Incineration.
    c. Long haul sanitary landfill (as an intermediate solution).
    d. Combination of the above.
    e. Auxiliary processing required to support the above methodologies.

f. Air cleaning adjuncts to the above.

g. Investigation of waste heat utilization processes including either steam turbine, or direct drive gas turbine.

3. Supplemental assays of industrial waste to obtain a firmer knowledge of composition and chemical characteristics.

4. Preparation and submission of a demonstration grant proposal to the Public Health Service Solid Wastes Program Administration.

5. Completion of all legal aspects related to and the execution of all actions required to bring about the formation of a Solid Wastes Management Authority in which the communities of Clifton, Passaic, Paterson and Wayne, New Jersey, are parties jointly to the action.

SECTION 9

FUTURE WORK

Future work under the study grant contemplates the following items.

1. Completion of a fourth assay in the series is necessary to round out information on variations due to seasonal activity. It is planned to complete that assay in August 1967.
2. Additional investigations on industrial waste composition; if necessary a composite of several tons proportioned according to the categories of industrial input will be obtained and studied.
3. A detailed engineering investigation coupled with the preparation of plans and specifications to provide the essentials required for the construction of a demonstration unit. This may require a reallocation of present project funds to allow the supplemental engineering to be performed.
4. Preparation of a demonstration grant application.
5. Final action on the formation of the "Lower Passaic County Solid Wastes Management Authority."
6. Dissolution of the present Quad-City Solid Wastes Committee and organization of Authority membership, administration, and staff.
7. Preparation of preliminary actions appropriate to the execution of work under the demonstration grant if it is approved.

SECTION 10

BIBLIOGRAPHY

1. American Public Works Association, Committee on Refuse Collection, *Refuse Collection Practice* (2nd Edition; Chicago, Public Administration Service 1953).

2. New York University, College of Engineering, Research Division, New York, N. Y., *Technical Report, Refuse Collection and Disposal Requirements for Contiguous Communities, May 1961*.

3. New York University, College of Engineering, Research Division, New York, N. Y., *Summary Report, Refuse Collection and Disposal Requirements for Contiguous Communities, May 1961*.

4. Ingram, William T., *Report - Refuse Collection and Disposal Quad-City Area - September 1966 - A Supplement to Refuse Collection and Disposal Reports for Contiguous Communities, May 1961*.

APPENDIX A2-1

SAMPLE # 3-9

NET SAMPLE WT 12#

TRUCK RECORD SHEET

COMMUNITY: PATERSON

DATE & TIME: MAY 19 1967 9:50 AM **DAY:** FRIDAY

ROUTE: MADISON AVE., 21 AVE. SPRING ST. GRAND AVE

TRUCK NO. & LICENSE NO.: 73 XL 2934 NJ

SCAVENGER: STOMATO

WEATHER TODAY: CLEAR - SUNNY **WEATHER YESTERDAY:** CLEAR - SUNNY

WGHT. OF TRUCK & LOAD: 46,720 **WGHT. OF TRUCK:** 27,200 **WGHT. OF LOAD:** 19,520

CLASSIFICATION:		TOTAL WGHT.	TARE	NET WGHT.	CORR.	ACTUAL NET WGHT.
1. Paper & Paper Products	-	88	42	46	Organic Corr.	46
2. Wood & Wood Products, Tree Branches, Etc.	-	35	32	3	-	3
3. Plastic, Leather and Rubber Products	-	46	42	4	-	4
4. Glass & other ceramics	-	60	34	26	-	26
5. Metal - All kinds	-	60	36	24	-	24
6. Stone-Sand-Ash & Other Inert Materials	-	61	43	18	-	18
7. Organic Garbage, Leaves Yard Clippings, Etc.	-	54	37	17	-	17
8. Rags & Textile Products	-	52	36	16	-	16
					TOTAL WT. =	154#

GENERAL DESCRIPTION & WEIGHT OF OVERSIZED OBJECTS REMOVED BEFORE THE QUARTERING OPERATION

OBJECT	NUMBER	WEIGHT (EA.)	TOTAL WEIGHT
CARPET	1	42	42
TELEVISION	1	37	37
IRON PLATE	1	23	23
TIRES	14	22	308
TAILPIPE	1	12	12
BED SPRING	1	45	45
MATTRESS	2	40	80
WASHING MACHINE	1	29	29
CARRIAGE	1	17	17
PIPE	8	8	64

REMARKS:

A2-2.

QUAD-CITY
SOLID WASTES PROJECT

APPENDIX A2-2

DATA SHEET
SOLID WASTES

____
Community

____
Classification

Prepared by ______________

Date ______________

Name of Company or Unit ______________________________

Address ______________________________
Street

____
City Zip

Names and Titles: Persons furnishing information

____

____

____

Major Products or Business ______________________________

____

____

SOLID WASTES PRODUCTION:

Total Production Per Week ______ # ______ Tons ______ cy

Estimate of Types of Waste Material by Class:	% of Total
Paper and Paper Products	
Plastic and Plastic Products	
Metal and Metal Products	
Ceramic Products	
Organic Chemicals	
Inorganic Chemicals	
Petro Chemicals - Petroleum Products	
Textiles, Rags and Apparel	
Lumber and Wood Products	
Leather and Leather Products	
Rubber and Rubber Products	
Mixed Commercial	
Glass and Glass Products	
Stone, Sand, Plaster	
Food - Vegetable and Animal Processing	
Miscellaneous - Not Otherwise Classified	

Estimate Percentage of Waste (Total = per Week)

Handled and disposed of on premises ______________________________

Carted away from premises ______________________________

A2-3.

Solid Wastes Inventory

WASTES HANDLING:

On Premises - By Dump ________ Sanitary Fill ________ Fuel ________

Incineration ________ Open Burning ________

Chemical Conversion ________ Salvage ________

Other ____

(Either check or indicate estimate of percentage of total)

Description of Disposal Unit (Area, Capacity, Manufacturer, Model, etc.)

____

____

____

Off Premises - Cartage by Owner ________ Private Scavenger ________

Municipality ____________

Name of Scavenger ____

Address of Scavenger ____

Collections per Week - Number ________________________________

Days of Collection ____

Wastes Carted to Dump ________ Sanitary Land Fill ________

Incinerator ________ Other ________________________

Name and Location of Disposal Area(s)

____

____

____

ESTIMATES OF COST OF SOLID WASTE HANDLING:

$ __________ Annual $ __________ Per Ton

________________________ Other Basis (i.e., per unit of Product or Raw Material)

(If split Methods of Disposal, provide similar data on each and indicate tonnage so handled.)

NOTES:

APPENDIX A2-3

CALCULATIONS TO OBTAIN WEIGHTS OF TYPICAL STRUCTURES, WHICH ARE OR MAY BE SUBJECT TO DEMOLITION IN THE FUTURE

1.0 1 Family Frame with Basement (55' x 22' ca 1200 sq ft)

1. 4" basement floor conc.		
2. 10" conc. foundation walls		
3. 1'-0" x 2'-0" footings		
4. floor system covering	3	
sub-floor (2 x 10 16" o.c.)	6.5	
1/2" lath plaster	4.5	14 #/ft^2
5. interior partition (120 lin. ft x 8'-0" 2 x 4 16" o.c. lath & plaster)		
6. exterior partition (2 x 4 16" o.c. insulation, lath & plaster, sheathing)	10	
siding	2	12 #/ft^2
7. ceiling		
plaster	8	
joist (2 x 6 16" o.c.)	3	11 #/ft^2
8. roof construction add 10% for slope and overhang		
roofing	3	
sheathing	4	
insulation	2	
2 x 6 - 16" o.c.	17	19 #/ft^2

1. 150 #/ft^3 x 4/12 x 1210	30.1 tons
2. 150 #/ft^3 x 10/12 x 8' x 154'	77.0
3. 2 x 150 #/ft^3 x 154'	23.0
4. 14 #/ft^2 x 1210	8.5
5. 16 #/ft^2 x 120 x 8	7.6
6. 12 #/ft^2 x 8 x 154'	7.4
7. 11 #/ft^2 x 1210	6.7
8. 19 #/ft^2 x 1210	11.5
Total	171.8 tons

All above divided by 2000 #/ton.

2.0 1 Family Brick with Basement ($55' \times 22'$ ca $1200\ ft^2$)

Same as 1 Family Frame except:
2. 12" conc. foundation walls
6. brick instead of siding

1 Family Frame	171.8 tons
2. 77 x 2/10	15.4
6. (45-12 $\#/ft^2$) x 8 x 154'	20.2
Total	207.4 tons

6 above divided by 2000 #/ton.

3.0 2 Family Brick--2 floors with Basement ($55' \times 22'$ ca $1200\ ft^2$)

Same as 1 Family Frame except:
4. two floor systems
5. two floors of partition
6. exterior partitions 18' high

1 Family Frame	171.8 tons
4. 8.5 x 2 - (8.5)	8.5
5. 7.6 x 2 - (7.6)	7.6
6. 7.4 x 10/8	9.2
Total	197.1 tons

4.0 2 Family Brick--2 floors with Basement ($55' \times 22'$ ca $1200\ ft^2$)

Same as 1 Family Frame except:
2. 12" conc. walls
4. two floor systems
5. two floors of partition
6. exterior partitions 45 $\#/ft^2$ at 18' high

1 Family Frame	171.8 tons
2. 77 x 2/10	15.4
4. 8.5 x 2 - (8.5)	8.5
5. 7.6 x 2 - (7.6)	7.6
6. (45 $\#/ft^2$ x 18 x 154') - 7.4	55.1
Total	258.4 tons

6 above divided by 2000 #/ton.

5.0 6 Family Frame--3 floors with Basement (55' x 44')

Same as 1 Family Frame except:

1. twice area of floor
2. 44' more wall
3. 44' more footing
4. six times floor area
5. six times interior partition
6. 36' high x 198'
7. twice ceiling area
8. twice roof area

1 Family Frame	171.8 tons
1. 30.1 x 2 - (30.1)	30.1
2. 150 #/ft^3 x 10/12 x 8 x 44'	22.0
3. 2 x 150 #/ft^3 x 44'	6.7
4. 8.5 x 6 - (8.5)	42.5
5. 7.6 x 6 - (7.6)	38.0
6. (12 #/ft^2 x 36' x 198) - 7.4	35.2
7. 6.7 x 2 - (6.7)	6.7
8. 11.5 x 2 - (11.5)	11.5
Total	364.5 tons

2, 3 and 6 above are divided by 2000 #/ton.

6.0 6 Family Brick--3 floors with Basement (55' x 44')

Same as 6 Family Frame except:

2. 12" conc. walls
6. 12" masonry walls exterior

6 Family Frame	364.5 tons
2. 2/10 (22.0 + 77.0)	19.8
6. (81 #/ft^2 x 36'^{289} x 198) + (7.4 - 35.2)	261.2
Total	645.5 tons

6 above divided by 2000 #/ton.

7.0 1 Story 100' x 200' Industrial Bldg. (200' x 100' 20,000 ft^2)

1. 12" x 15'-0" masonry walls 8% void
2. 1'-0" x 2'-0" conc. foundation
3. steel frame 6 #/ft^2
4. columns 3'-0" x 5'-0" x 1'-0" x 15
5. build-up roof 5 ply
6. 3" insulation
7. 6" conc. floor
8. 8" x 15'-0" masonry wall interior partition x 50'
9. 20 ga metal deck
10. foundation for 8 50' x 1'-0" x 2'-0"

1.	(15 x 80 #/ft^2 x 600) - 8%	342 tons
2.	2 x 150 #/ft^3 x 600	90
3.	20,000 ft^2 x 6 #/ft^2	60
4.	3 x 5 x 150 #/ft^3 x 15	16.8
5.	20,000 ft^2 x 6 #/ft^2	60
6.	20,000 ft^2 x 3 #/ft^2	30
7.	20,000 ft^2 x 150 x .5	750
8.	15 x 55 #/ft^2 x 50'	20.6
9.	20,000 ft^2 x 3 #/ft^2	30
10.	2 x 150 #/ft^3 x 50	7.5
	Total	1396.9 tons

All above divided by 2000 #/ton.

APPENDIX A2-4

TYPICAL CALCULATION
% COMBUSTIBLE MATERIAL
1 FAMILY FRAME CONSTRUCTION

	#/ft	
	Units	Total
4. covering	3.0	
sub-floor) 2 x 10 16" o.c.)	6.5	9.5
5. 2 x 4 16" o.c.	2	2
6. 2 x 4 16" o.c.	2	
sheathing	3	
siding	4	9
7. 2 x 6 16" o.c.	3	3
8. roofing	3	
sheathing	4	
2 x 6 16" o.c.	8	15

$$\frac{\#}{ft^2} \times \frac{\text{tons of combustible}}{\#/ft^2 \text{ of item}}$$

4. 9.5/14 (8.5)	5.8 tons
5. 2/16 (7.6)	.9
6. 9/12 (7.4)	5.6
7. 3/11 (6.7)	1.8
8. 14/19 (11.5)	8.5
Total combustibles	22.6 tons

$$\frac{22.6}{171.8} \times 100 = 13.15\%$$

APPENDIX A2-5

INTERVIEW WITH DEMOLITION CONTRACTOR

1.0 Purpose

Stanley and John Lacz interviewed Mr. Michael Ottilio, one of the largest demolition contractors in New Jersey to obtain a better insight of the demolition activities as related to solid wastes generation and disposal. Mr. Ottilio was most helpful and answered to the best of his ability the questions we asked. In addition, we inspected, with Mr. Ottilio, the Ottilio landfill located behind the Motor Vehicle Inspection Station near the intersection of Routes 80, 46 and 23. Below is a summary of the information received.

2.0 Typical Solid Wastes from Demolition

1 family house (frame) on 25' x 100' lot - 3 to 4 trailer loads 40 yds volume & 14 tons/load
1 20' x 30' house frame - 3 to 4 trailer loads
1 100' x 200' factory (1 story brick, wood trusses, wood roof, concrete floor, misc. piping, electrical, etc.) - 105 trailer loads
1 4 story frame 50' x 100' lot - 20 trailer loads
1 family brick (2 story) (brick salvaged) - 3 to 4 trailer loads
1 2 family brick (2 story) (brick salvaged) - 5 to 6 trailer loads

It will be noted that the salvageable materials are normally stripped and sold. Brick is placed aside and either salvaged (used brick) or used to fill foundations. The same applies to concrete foundation walls and slabs. In some cases, where new building construction is scheduled, the brick and concrete rubbish will be hauled away.

Wood, siding, roofing is normally broken up on site by demolishing grapple or bulldozer before being loaded onto trailers. Some soil (dirt) is stripped and mixed with combustibles to minimize or eliminate the possibility of future fires at sanitary landfills.

As you can see, there are many alternates in the demolition contracting field to operate profitably.

3.0 Burning-On-Site

In large demolition projects, or where permitted (legal or illegal), burning of combustible debris is practiced.

A good hot fire (bright yellow flame) is obtained and maintained. Efforts are made to limit the amount of tar paper, floor tiles and other rubber, plastic and asphalt products from being introduced into the fire. More about on-site burning will be in the summary report on construction/demolition wastes.

4.0 Ottilio Sanitary Landfill

During active demolition periods Ottilio obtains from the Quad-City area solid wastes at the rate of:

144 acre feet/year	(2 to 3 months of the year)
60 acre feet/year	(9 to 10 months of the year)

$$\begin{aligned} 144 \times 3/12 &= 36 \\ 60 \times 9/12 &= \underline{45} \\ & 81 \text{ acre feet/year} \end{aligned}$$

The landfill was low and swampy. Ottilio uses the excavation by drag line approach, dumps waste in excavation and then cover/compact as practiced by many of the landfills in the area. The landfill is exceptionally clean and orderly due to the fact that no organics are deposited. The demolition wastes are well broken up and mixed with soil, etc., before being deposited.

5.0 Report

A report on construction/demolition wastes in the Quad-City area is being prepared and will be issued shortly.

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APPENDIX A4-1